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NEW AND IMPROVED DEVICES FOR FISH CULTURISTS.*

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ARTIFICIAL BASS NEST.

The artificial bass nest, like others in use, and shown in Fig. 1, consists primarily of a container for the gravel, constituting the net proper, and a shield to furnish the seclusion required by the nesting fish. Both container and shield, however, are of distinctive design, and the shield, which is detachable, is provided with a waterproof record holder and indicator projecting above the water.

The nest proper is an iron hoop 2 feet in diameter, made of 1½-inch by ⅛-inch band iron. This hoop, placed in the pond and filled with gravel, holds the latter within its circumference without the necessity of any bottom and may be left in position permanently. Riveted at each of three quartering points on the outside of the hoop is an iron socket or slot, of size to accommodate a standard 1 inch wide and ¼ inch thick. By means of these slots the removable shield is adjusted to the hoop.

The shield, 2 feet high and semicircular to fit one side of the hoop, is made of ordinary galvanized sheet iron riveted to three iron standards. The standards, which are 1 inch wide by ¼ inch thick, extend 2 inches below the sheet of iron they support, and are pointed at the lower end for ready adjustment to the sockets in the hoop. The two end standards are 26 inches in height and are flush with the top edge of the shield. The middle standard is higher, projecting above the shield to hold the indicator and record case. The height of the projection is determined by the depth of the water in which the nest is used, the indicator to be always visible above the surface of the pond. The shield and container are coated with paint.

The record holder consists of a waterproof case to contain cards or small sheets of paper and has a number and an indicator on its face. The case is made of two rectangular pieces of thin sheet metal, preferably copper, 2½ by 5 inches, with rolled edges to permit one side of the case to slide upon the other. Into the back are slipped the cards or sheets of paper containing detailed records of the nest. The nest number is stamped or painted on the upper half of the face of the case; in the lower half is fixed a metal pointer, in a dial upon which appear symbols which will indicate to the fish culturist whether the nest is "cleaned up" or contains eggs or fry. A metal pocket is soldered

Fig. 1.—ARTIFICIAL BASS NEST. Fig. 2.—BASS FRY RETAINING SCREEN AND TRAP.

Fig. 3.—COLLECTING TUB WITH FLOAT.

Fig. 4.—FISH RETAINER WITH FLOAT.

Fig. 5.—FISH ATTENDANT'S OUTFIT—AERATOR SCREEN, PLUNGER, COMBINED ICE PICK AND SCAFF NET.

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upon the back of the case, by means of which to fit it to the tall standard of the shield.

The especial advantages of this nest are as follows:

1. The shield can be removed to permit placing the retaining screen around the nest without roiling the water or disturbing the nest proper, thereby avoiding injury to the fry by the rolling of the gravel.

2. The nest proper, remaining permanently in the pond, is always in readiness for use without the expenditure of labor to renew each year, and when once installed requires only attaching of the shield, which can be done in the space of a moment.

3. The nest, being of heavy metal, will remain stationary in the pond without being weighted down to prevent floating.

4. A separate and complete record of each nest can be kept as its product advances to different stages, while its condition can be determined from the shore at a glance without disturbing the fish by entering the water or going to the nest in a boat.

5. Nest and shield are easily stored. Fifty of the shields require a space but 2 feet wide, 2 feet high, and 26 inches long.

BASS FRY RETAINING SCREEN AND TRAP.

The retaining screen and trap illustrated in Fig. 2 is intended for use in connection with the bass nest just described. It combines with the ordinary cylindrical retainer a device by means of which the fry are entrapped and may be readily lifted from the nest. Certain improvements in the construction of the retainer are also important features.

The retaining screen is made of a piece of 14-mesh galvanized wire cloth 3 feet in width, stretched around a frame consisting of two iron hoops and four iron standards. The hoops are made of ⅛ by 1 inch iron bands and are 3 feet in diameter; the standards are 3 feet high. The joinings are everywhere made with stove bolts, which also secure the wire cloth to the frame. At the seam the wire cloth is lapped directly over one standard and an extra upright 3½ feet long is bolted over the lap. The circular inclosure thus built is readily "knockdown" for storage purposes. Upon the projecting upright is fitted the record holder, which was attached to the nest shield of Fig. 1 and is now to be transferred to carry on the record for the fry. All metallic parts are painted.

The trap is within the retainer. It consists of a hoop fitted over the bottom hoop of the retainer and securing about its circumference a piece of bobbinet so shaped and seamed as to form a blunt cone about 2 feet high when held in place within the wire-cloth screen. The top of this cone is open, the bobbinet here fitted and secured to an iron ring 4 inches in diameter. To hold the cone in position two cords attached on opposite sides of the opening are carried to the upper rim of the retainer and there fastened by means of bent-wire hooks at the ends of the cords.

As the bass fry ascend from the nest their natural tendency is to follow the inside of the cone upward to the 4-inch opening, through which they pass to the upper section of the retaining screen. After they have all ascended, this opening is closed with a tight-fitting cap made of a circular piece of bobbinet held in at the edge by an elastic gathering string. The fish are then in captivity. To remove them from the pond the apparatus is lifted to the surface of the water, the cords holding the cone are released and the cone telescopes, forming a scaff net, which is then detached from the bottom hoop of the retainer, placed over the collecting tub, and the fish liberated therein.

The advantages of this combined retaining screen and trap are as follows:

1. All the fry that are able to rise from the nest can be captured.

2. They can be taken from the trap at any time desired without regard to roiliness of the water or low temperature.

3. The device is useful in the capture of bass fry in inland lakes which have become overstocked and from which it is desirable to transfer the fish to barren waters or waters more accessible to sportsmen.

COLLECTING TUB.

The collecting tub is convenient for use in connection with the trap just described. It is constructed of ordinary galvanized iron, is 3 feet in diameter, 14 inches deep, and has a 2-inch flaring rim with outer circumference to fit the hoop of the cone-shaped trap, as pictured in Fig. 3. At each of two opposite points in the side is inserted a piece of perforated tin, 7 by 10 inches, extending to within 4 inches of the bottom. Two handles are attached below the rim on the sides transverse to the perforated inserts, and the tub is painted inside and out.

When in use the tub is placed in a wood float 4 feet square, which permits it to be easily towed from nest to nest as the collections are made. In emptying the tub its contents are poured out over the solid side rather than the perforated.

This tub has the advantage of allowing the fish a free circulation of fresh water during the process of collecting, a condition very essential during warm weather. Necessity for changing the water is thus obviated, and handling of the fish, which should always be avoided as much as possible during warm weather, is minimized.

Fig. 6.—SEINE FOR COLLECTING FINGERLING BASS.

FISH RETAINER.

The fish retainer shown in Fig. 4 is a convenient means of temporarily confining fish awaiting shipment. It is made of ordinary galvanized iron, and is in effect a taller and slenderer form of the collecting tub with the addition of a combined cover and bail. It is 10 inches in diameter and 20 inches high, with a 2-inch flaring rim and with two perforated strips of tin inserted opposite each other in the sides. The perforated inserts are 6 inches wide by 14 inches in height, reaching from the lower edge of the rim to within 4 inches of the bottom of the receptacle. A stiff wire bail, to which the cover is fastened, is attached on the perforated sides, and the receptacle is painted.

When in use this retainer is set in a wooden float to prevent its sinking. Such floats may be constructed any length, to accommodate any number of retainers, but sections 26 inches wide and 7 feet long, which will accommodate 10 retainers, are found to be most convenient. The apparatus is placed in fresh or running water, and the fish to be carried in one transportation can are placed in one retainer. In emptying the retainer its contents should be poured out over the solid sides instead of the perforated, to prevent injury to the fish.

This device has the advantage of allowing shipments of fish to be prepared in advance of the time of departure, as a free circulation of water is permitted at all times and the fish can be held any reasonable number of days. It obviates extra handling of the fish, which is to be avoided as much as possible, and also enables one man to prepare the shipment without assistance, which is of great convenience for night departures.

FISH ATTENDANT'S OUTFIT.

The fish attendant's outfit comprises an aerating device and a combination ice pick and net, for use in the transportation of fish, and is on view in Fig. 5. The aerator consists of a cylindrical screen made of perforated zinc or tin, and a perforated funnel-shaped plunger with a long handle. The screen is 6½ inches in diameter, 21 inches high, with a 2-inch slightly flaring collar at the top, has a perforated bottom, and is fitted with a wire bail. Two heavy wires, crossing each other at right angles, are soldered 2 inches from the bottom to prevent the plunger from striking the latter. The slender dimensions of the screen permit it to be inserted into the ordinary transportation can.

The plunger may be made of an ordinary tin funnel of 6 inches mouth diameter, a shallow tin pan of the same diameter, and a ¼-inch rod bent to form a loop at one end. The funnel is perforated with nail holes, as is also the bottom of the pan, and the latter, inverted, is soldered over the mouth of the funnel. The rod is inserted into the tube of the funnel, giving the plunger a total length of 18 inches.

To operate the aerator, the plunger is churned up and down in the screen. The screen filled with ice may be used in cooling the water in which the fish are held.

Both as aerator and cooler this device is especially useful in transporting fry which are the more susceptible to injury in handling, such as shad, pike, perch, and whitefish. With these means, moreover, the attendant can give proper attention to a large number of fish in a short space of time and with a minimum amount of labor.

The combined net and ice pick consists of a semicircular frame of 10 inches long dimension, made of No. 6 wire and covered with soft net of any desired mesh. This is fitted into a wooden handle, the opposite end of which holds a disappearing point 3 inches long, made of ¼-inch spring steel.

The net is of use in pouring water from transportation cans in order to replenish with a fresh supply, or for purposes of "doubling up" the contents of two cans, as may be necessary just before delivering from the train. It also takes the place of the siphon and scaff net usually carried by attendants in charge of shipments of fish, and since these and the ice pick are usually carried separately, the combination device reduces the number of articles from 3 to 1.

SEINE FOR COLLECTING FINGERLING BASS.

The seine for use in collecting fingerling bass, made of heavy bobbinet, is rigged upon two handles consisting of bamboo poles 14 feet in length. The web is 16 feet long and 4 feet wide, corked and leaded, and is attached at each end to a 4-foot steel brail ¼ inch in diameter. The brails are fastened to the bamboo handles by strap-iron hinges, which allow the brails to break but one way. A heavy cord attached to the lower end of each brail passes through a screw eye in the handle at a point the brail's length distant from the hinge. In operation the seine is projected over the water with the brails extended, the back of the hinges downward. The handles are then given a half turn, allowing the brails to drop at the hinges, beyond the school of fish. The seine falls into the water and as soon as the leads touch the bottom of the pond the cords are tightened. Pulling from the lower end of the brails with the hinges bent, the cords draw upon the bottom of the seine, and it is easily hauled ashore.

The use of this seine, since it can be operated from shore, avoids the roiling of the water which occurs when the operators wade into the pond, and it makes possible the capture of fish at any desired time without drawing off the water. The seine is of advantage, among other purposes, in thinning out the fish from time to time to avoid exhaustion of the food supply and consequent cannibalism. This seine and the mode of handling it are illustrated in Fig. 6.

SHIPPING CASE FOR FISH EGGS.

A shipping case designed for shipping fish eggs either to foreign countries or points at any distance throughout the United States is represented in Fig. 7. It can be constructed of any sound lumber ⅞ inch thick. The outer case is 2 feet wide, 2 feet high, and 3 feet long, with corners halved together to permit of nailing both sides and ends. Its sides are lined with asbestos packing paper, and the bottom with rubberoid roofing paper. The inner case is made of any light ½-inch lumber and is 19 inches high, 20 inches wide, and 32 inches long. The bottom is made of ordinary galvanized iron and has a slope of 2 inches toward the center to a waste pipe. The outside of this inner case is covered with rubberoid roofing paper.

Cleats in the ends in the bottom of the outer case support the inner one and make an air space below it, at the same time raising it so that it projects 1½ inches above the upper edge of the outer case. Between the walls of the outer and inner cases is a 1-inch air space, and this is closed at the top by means of a strip of lumber 2 inches wide inserted edgewise and flush with the inner wall, making the

space airtight. This projection fits into the top of the case when the latter is closed.

The inside case is divided into five compartments, one at each end and in the middle for ice, the two others for trays, the partitions all flush with the inner case. The ice compartments are 3 inches wide and of the full width and depth of the inner case. The middle compartment is removable. The partitions are made of ½-inch mesh galvanized-wire cloth and are held in place with 1-inch cleats nailed upright to the sides of the inner case. These cleats also hold the tray stacks in vertical position, and the space they make allows for air circulation and the dripping of the ice hoppers which are to be placed above. It also allows easy access to the trays and permits of inspecting them at all times without disturbing the ice.

The case holds 24 trays for eggs, 12 in each compartment. The trays are made of ½-inch lumber and are 8½ inches wide, 18½ inches long, and 1 inch deep. The bottoms are of fine-mesh wire cloth. Each side of each tray is perforated with five equally spaced ½-inch holes to allow air circulation.

Over each tray stack, resting upon the ends of the vertical cleats, is an ice hopper 10½ inches wide, 18½ inches long, and 2 inches deep, made of ordinary galvanized-iron bottom and sides, with wooden ends. The bottoms of the hoppers are perforated near the sides with ½-inch holes to allow the water to escape. Over the lower end of the waste pipe to prevent the cool air from escaping is a bowl-shaped cap which is always filled with water.

The top of the case, which is hinged, fits tightly over the rabbet formed by the projecting edge of the inner wall, making an air-tight chest. It is provided with two hasps in front, and is lined with a single sheet of asbestos, a layer of ½-inch lumber, and over these a covering of rubberoid roofing.

The empty case weighs 88 pounds. The space devoted to ice will hold 60 pounds. Allowing 20 pounds for eggs and moss, the whole shipping weight would be 168 pounds. The case is designed to hold about 80,000 steelhead trout eggs, 120,000 lake trout eggs, 250,000 brook trout eggs, or 1,000,000 whitefish eggs.

This case has the advantage of allowing easy access to the eggs for inspection at any point *en route*. It permits of free circulation of air, thereby producing an even moisture and even temperature for all of the trays. For local shipments or field work the stacks of small trays, ice hoppers, and central ice compartment may be removed and large trays substituted, making a combination case, and avoiding the necessity for three separate styles, as usually required for different distances. The present case has also the advantage of carrying a maximum number of eggs at a minimum weight.

Coating the case inside with paraffin wax will prevent odors, or moisture from swelling the box.

The following tables record a 36-day test given a roughly constructed case of this type, beginning January 29 and ending March 5, 1906. During the first 26 days the case contained 53,000 wall-eyed lake trout eggs. It was not filled, only 10 of the 24 trays being used. Nine of them contained 5,000 eggs each and one had 8,000.

RECORD OF FIRST 26 DAYS OF TEST.

Test Day.	Temperature of Room. Deg. F.	Temperature on Egg Trays. Deg. F.	Ice Used. Pounds.
1	75	34	80
2	64	34	..
3	32	35	..
4	71	36	30
5	76	34½	..
6	70	35	..
7	60	35	..
8	69	37	76
9	74	34½	..
10	85	35	20
11	85	36	..
12	82	39	48
13	85	35½	16
14	84	35	20
15	90	35½	25
16	84	35	20
17	85	35½	20
18	90	36	20
19	87	36	20
20	80	36	20
21	81	36	20
22	80	36	20
23	70	36	20
24	82	36	20
25	84	36	20
26	85	35½	..
Total	..	..	515

The eggs were looked over on the seventh day and 44 dead eggs were removed; on the sixteenth day 121 dead eggs were removed; on the twenty-sixth day 168.

On the sixteenth day the moss placed over the eggs was removed, the water squeezed out, and the moss then replaced.

The above test was made in the boiler room, and on the ninth day the case was moved nearer the boiler, which accounts for the rise in outside temperature.

On the twenty-seventh day the eggs were all removed from the case, the latter thoroughly cleaned, and the tray containing 8,000 eggs was replaced for a further test of ten days. During the first five of these days the case was outside in a temperature ranging from 14 deg. to 50 deg. F., the last five it was inside the hatching room at a temperature of 50 deg. F.

RECORD OF LAST 10 DAYS OF TEST.

Test Day.	Air Temperature — Noon. Deg. F.	Air Temperature — Midnight. Deg. F.	Egg Temperature, Noon. Deg. F.
27	50	43	34
28	35	31	34
29	34	19	34
30	23	14	33
31	30	25	32
32	50	50	33
33	50	50	34
34	50	50	35
35	50	50	35
36	50	50	36

These eggs were then removed to Clark hatching troughs and at the end of one week hatched, producing good strong healthy fry. The fry were held until the sac was nearly absorbed, and then planted.

The tray containing the 8,000 eggs stood the test for the entire thirty-six days, and at this rate would give the capacity of the case as 192,000 lake trout eggs, thus demonstrating that a much larger number of eggs than claimed for it can be safely transported in this case should occasion demand. During the above 10-day test but 20 pounds of ice was consumed.

FIG. 7.—SHIPPING CASE FOR FISH EGGS.

A POSSIBLE LAND CONNECTION BETWEEN ASIA AND NORTH AMERICA

WAS there ever a land connection between Asia and North America? Mr. Adolf Knopf considers that question in a recent publication of the University of California. All the evidence from which conclusions of some positiveness can be drawn record only epochs of more widely spread submergence and increased separation of the continents than ever existed during Cenozoic time. It has been determined beyond question that the uplift of submerged portions of the continental border was accompanied by marked deformation. During the upraising of the marine-wrought York bench, a differential warping of 400 feet in a distance of fifteen miles was produced. Dawson, writing in 1894, believed that the available evidence pointed to a general submergence during the later Miocene, uplift of the present land areas at the close of the Miocene, and subaerial conditions, with possibly brief intervals of depression, during post-Miocene time. The evidence of the Miocene submergence, however, was based on the occurrence of the Nulato sandstone on the lower Yukon, which had been referred to the marine Miocene by Dall, but which subsequent work has shown to be of Upper Cretaceous age. The observations of the last decade show that it is unsafe to make wide-reaching generalizations embracing the whole region of Bering Sea and its environs. The diastrophic movements have been too complex, the oscillations of the strand line too frequent and localized, and the information concerning them too scanty. Recognizing those elements of uncertainty, Mr. Knopf believes we may sketch the Cenozoic history of the region as interpreted from the evidence now available.

The Eocene and Miocene were apparently periods of comparative stability and were marked by the reduction of the region of Seward Peninsula to a peneplain. The submarine plateau of Bering Sea, which is considered by Dawson as belonging physiographically to the continental plateau region, may have been evolved during those periods, and Asia and America connected by a land mass.

At the beginning of the Pliocene, Seward Peninsula possessed approximately its present shore line. In terms of the physiographic record the facts indicate that the peninsula possessed approximately its present outline at the time of the marine planation of the York bench. The York bench is undoubtedly older than the loose sands and gravels of the Nome beach deposits, and if we accept the age of the latter as determined paleontologically, is, therefore, of pre-Upper Miocene age. It is difficult to reconcile this great age with the splendid state of preservation of the marine terrace.

During the remainder of Cenozoic time the dominant movement affecting Seward Peninsula has been that of uplift. The crustal instability of the region, the known large differential warping that has accompanied elevatory movements, and the shallow depth of Bering Sea render it, however, highly probable that at various times brief periods of land communication have existed between the continents.

The general conclusion is therefore borne upon us that if the problems of the intercontinental migration of faunas demand periods of terrestrial communication between the two mainlands during Cenozoic time, the physical evidence, so far as now known, favors the probability of intervals of continuity of the adjoining land masses of Asia and North America.

THE STUDY OF METEORS.

NO NEW evidence of connection between meteors and comets was added in 1909 to the four old and well-known examples. The Boötid swarm of meteors appeared with exceptional brilliancy in Spain on January 2nd, 1909. On February 22nd observers in many parts of England saw a large meteor which left in its wake a trail that remained visible, slowly changing in form, for several hours. From the descriptions of the deformation of the trail, its component particles appear to have traveled about 300 miles per hour, a velocity that is not certainly known to have been attained by any body moving through the air. In England also on October 6th a bright meteor appeared in full daylight and burst with a detonation that shook the windows and was mistaken for an earthquake. Many persons thought that they felt a wind caused by the meteor's flight, detected its odor or saw it fall near them, when it was really more than 100 miles away.

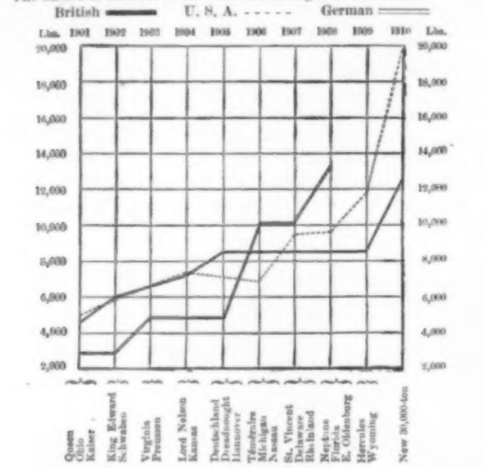
A new explanation of stationary radiant points has been suggested by W. H. Pickering. Several swarms of meteors may have nearly the same radiant point but may cross the earth's orbit at different points, producing an apparent confusion between swarms appearing at short intervals. These swarms, like a well-known family of periodic comets, may have some connection with the orbit of Jupiter.

THE 30,000-TON BATTLESHIP.

ITS EFFECT ON NAVAL POLICIES.

BY AN ENGLISH CORRESPONDENT.

The announcement that plans have been prepared in the United States for a battleship of 30,000 tons has naturally been the subject of a great deal of discussion in England, where so far no battleship has yet been laid down with a greater displacement than 20,250 tons. In lay circles attention has, not unnaturally, been almost confined to the question of displacement; but by far the most important feature of the new design is the armament. In these days of widespread naval rivalry tonnage is bound to go on increasing, but to advance to 30,000 tons at one leap,



This diagram shows in a striking manner how the erstwhile superiority of British battleship designs has been converted into a very decided inferiority. The figures at the side indicate the weight of metal fired from all guns with a shell of 50 pounds or over, the basis being one round from each gun. The names of the vessels taken for comparison are given at the foot of the diagram.

and at the same time to increase the caliber of the main armament to 14 inches, will mark a very definite milestone in the history of naval construction.

Before examining in detail the real and full portent of the 30,000-ton ship, it will not be without interest to trace briefly the development of the battleship in recent years. The last diagram shows the enormous increase in displacements which has been made, especially since 1904-5. Up till that year, British battleships were well ahead of the rest of the world in size, and the English advantage was still further emphasized by the production of the 17,900-ton "Dreadnought" in 1905. Fervent eulogies were poured out upon that ship when her details became known, and there were many responsible men in England who claimed that she gave to that country an advantage which could never be wrested from it. It is now a matter of history that the "Dreadnought" simply provided a fresh starting place for the naval powers. In the "Dreadnought" year of 1905 the United States laid down the 16,000-ton "New Hampshire"; Germany began work on the last two ships of the 13,200-ton "Deutschland" class—the largest she had ever built; but the effect of the "Dreadnought" was instantaneous. Germany advanced the tonnage of her next ships to 17,760; and although the United States in the 1906 ships ("Michigan" and "South Carolina") remained content with 16,000 tons, the all-big-gun principle was adopted, and the foundations laid for a policy which has now given us the most powerful and satisfactory ships of the "Dreadnought" type in the world. The principal characteristics of successive British and American dreadnoughts are given in the following table:

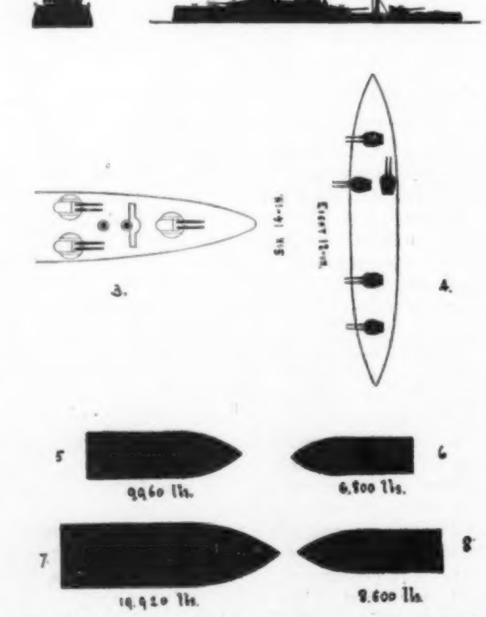
	British.	American.
1906...	"Bellerophon," 18,600 tons. Ten 12-inch guns.	"Michigan," 16,000 tons. Eight 12-inch guns.
1907...	"St. Vincent," 19,250 tons. Ten 12-inch guns.	"Delaware," 20,000 tons. Ten 12-inch guns.
1908...	"Neptune," 20,250 tons. Ten 12-inch guns.	"Florida," 22,000 tons. Ten 12-inch guns.
1909...	"Hercules," 20,250 tons. Ten 12-inch guns.	"Wyoming," 26,000 tons. Twelve 12-inch guns.

It will be seen that ever since the production of the "Dreadnought" four years ago, British displacements have increased by only 2,350 tons (17,900 to 20,250). On the other hand, American vessels have advanced 10,000 (16,000 to 26,000). Also, British main armaments have not altered, save that from the "St. Vincent" onward the 12-inch guns are of 50 calibers, instead of 45 as in the "Dreadnought" and "Bellerophon." American 12-inch armaments, starting two below the British numbers, are now two ahead, while the anti-torpedo batteries of our ships have kept in front of the British thus:

British.	American.
"Dreadnought," 24 12-pounders	
"Bellerophon," 16 4-inch (31-pounders)	"Michigan," 22 3-inch
"St. Vincent," 20 4-inch	"Delaware," 14 5-inch (70-pounders)
"Neptune," 20 4-inch	"Florida," 16 5-inch
"Hercules," 20 4-inch (Doubtful)	"Wyoming," 22 5-inch

At the same time, as the first diagram shows, the new German ships have also outstripped the British in offensive power, although there is no reliable information as to the German vessels after 1908. The British figure for 1910 is calculated on the basis that the statement giving the ships of that year's programme an armament of ten 13.5-inch guns is accurate. A typical ship of each year's programme is taken, and the total gun-fire worked out on the basis of one round from each gun firing a shell of 50 pounds or more. It will be seen that the British 13.5-inch gun ships are already outclassed on this basis by the German vessels of the 1908 programme, which mount twelve 12-inch and twelve 6.7-inch, and are run very close by the American "Wyomings."

Turning now to the 30,000-ton ship and its suggested armament of twelve 14-inch guns, some even more startling figures and comparisons may be made. The 14-inch experimental gun which is under construction at Midvale, and is shortly to be tested at Indian Head, is a weapon of 50 calibers length, and fires a shell of 1,660 pounds with an initial velocity of 2,800 feet per second. The British 12-inch gun mounted in the "Dreadnought" and in the three "Bellerophons" is only 45 calibers long, and fires a shell of 850 pounds with a muzzle velocity of 2,900 foot seconds. It will be seen that the smashing power of the American gun is infinitely greater; but what of the gun-fire of the ship armed with twelve of them? The "Dreadnought's" gun-fire—and the figures remain the same down to and including the 1909 ships—is

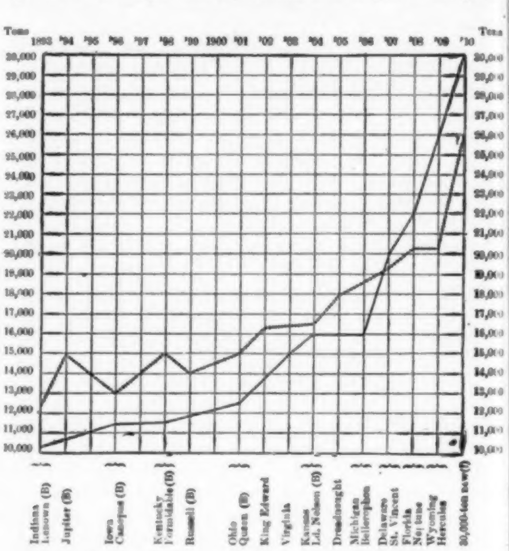


Remarkable comparison between the proposed 30,000-ton battleship and the "Dreadnought." Fighting bows on, and thus exposing the minimum target, the new vessel could face the full broadside of the "Dreadnought" and still bring to bear a gun-fire superior by nearly 50 per cent. This is on the assumption that the new ship could fire only six guns ahead. Eight is the more likely number. The full gun-fire of the 30,000-ton ship would be more than twice as great as that of the "Dreadnought."

1 and 2 are the proportionate targets presented when bringing to bear the guns shown in 3 and 4. 5 and 6 show the comparative weight of metal from these guns, and 7 and 8 the comparative weights discharged by the whole armament.

10 by 850, or 8,500 pounds. The 30,000-ton ship would have a fire of 12 by 1,660, or no less than 19,920 pounds, or more than two and one-third times as great. A British ship carrying ten 13.5-inch would have a gun-fire of 12,500 pounds. The 30,000-ton ship would exceed this by 7,240 pounds, or 59 per cent.

The second diagram accompanying this article illustrates the enormous tactical advantage of the proposed new ship. No information has yet been pub-



This diagram shows how, after the first effects of the "Dreadnought" innovation began to wear off, the size of American battleships has exceeded the British. It should be read in conjunction with the previous chart, especially as concerns the last few years.

lished showing what arrangement is proposed for the six turrets, but it is doubtful whether the all-on-the-center-line plan would be found satisfactory. It certainly would not give such tactical advantages as the orthodox arrangement, which, as modified in the Brazilian ships of the "Minas Geraes" class, would result in four turrets being placed on the center line, the one nearer the waist of the ship firing over the outer one, with another turret on each beam. This may be otherwise expressed by likening it to the "Michigan" plan, with two beam turrets added. This arrangement would give a broadside fire of ten guns, and an ahead and astern fire of eight. For the purpose of the following comparisons, however, it is assumed that only two turrets are placed on the center line, one forward and one aft, the other four being placed at the corners of the superstructure, after the plan of the 8-inch gun turrets of the "Kansas" class. This would not be as satisfactory as the plan already outlined, since it would allow of a broadside fire of only eight guns, with six ahead and astern—the same as the eight-gun British "Dreadnought" cruisers. However, it is convenient as the minimum possible, if we bar the all-center-line system.

With six 14-inch guns bearing ahead, the 30,000-ton ship would have a fire in this direction of 9,960 pounds. The broadside fire of the "Dreadnought" is only 8,500 pounds. In other words, the American ship, presenting only an end-on target, could bring to bear a greater fire than the "Dreadnought" fighting broadside on, and presenting a target four or five times the size. The American ship would still have available the same number of guns astern, or could bring to bear four guns (6,640 pounds of metal) on one broadside and two on the other. Such facts as these bring out the stupendous advance in power the 30,000-ton ship represents.

A word in conclusion on the size of battleships generally. International naval competition works along two lines—numbers and individual power. Since the adoption of the 12-inch gun and single-caliber armaments, the latter phase has naturally taken the direction of increasing the number of guns mounted, for which, of course, increased displacements have been necessary. But the cost of this policy is enormous. Besides the ship itself (the cost of construction may be taken at $500 per ton) there has to be taken into consideration the cost of new and enlarged slips, new docks, the dredging of harbors and channels, larger crews, and greater depreciation. In face of these facts, it is natural that constructors and naval officers should begin to look in the direction of more powerful guns for the next increase in fighting strength. Col. Cuni-

berti, the gifted Italian constructor, to whom the credit of first suggesting the "Dreadnought" type of ship is generally accorded, realized three years ago that the 12-inch gun was not powerful enough to do all that was expected of it, instancing the Russo-Japanese war for proof. He advocated the 16-inch gun, but said that it might be advisable to adopt an intermediate caliber before going so far. It is significant of what the future has in store that the Italian government is this autumn going to lay down two ships of 21,000 tons—the "Galilieo-Balilei" and the "Michel-Angelo-Ruonarotti"—which are to steam 23 knots and to be armed with eight 14-inch guns, with a secondary battery of twenty 4.7-inch. Twenty years ago Great Britain mounted two 16.25-inch 110-ton guns in the battleships "Benbow," "Sans Pareil," and "Victoria," the last named of which was rammed and sunk in 1893. There is no doubt whatever that the next decade will see guns of that or even a greater caliber mounted in ships of the principal naval powers. It is one of the inevitable results of competition.

A NEW TYPE OF SUBMARINE BOAT.

BAYER'S DUPLEX BOAT.

ALTHOUGH the great naval powers of the world have labored for many years and have spent very large sums of money on the construction of submarine boats, no really practical, reliable and seaworthy vessel of this character is yet in existence. The submarine cannot become a formidable adversary of the warship while it retains the elongated form which prevents it from turning in a small space and makes it liable to destruction by the swell of a large vessel.

These considerations have led Carl Bayer, an engineer of Stuttgart, to devise and patent the strikingly novel and original submarine, or rather, submergible boat, which is here described and illustrated. This peculiar craft comprises two distinct vessels, which are connected by two steel arms. The principal vessel is spherical and is composed of two concentric shells. Two short tubes, situated at the ends of a horizontal diameter, extend inward from the outer shell, and in these tubes the inner shell is suspended on ball bearings. The hollow trunnions of the inner shell protrude from the tubes, and their outer ends are embraced by the ring-shaped ends of the steel arms, to which they can be rigidly attached by means of adjustable clutches. In this manner the inner shell can be prevented, by the weight of the auxiliary vessel, or float, which is attached to the other ends of the steel arms, from rotating when the outer shell is turned by a motor placed inside the spherical vessel. The outer shell bears a number of flanges, lying in meridian planes which intersect in the horizontal axis of rotation. When the vessel is not submerged, it is propelled by means of these flanges, which act like the paddles of a side-wheel steamer, and drags the float after it by means of the steel arms which, in this case, are nearly horizontal.

The appearance of the compound vessel, when it is

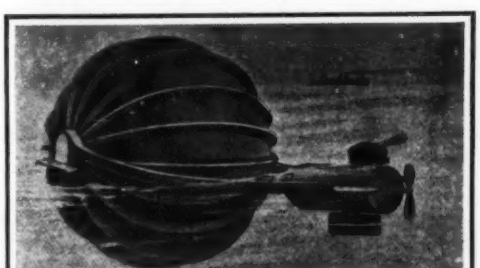


FIG. 1.—THE BAYER SUBMERGIBLE BOAT AFLOAT AND TRAVELING AT FULL SPEED.

moving over the surface of the water, is shown in Fig. 1. When the speed is increased the vessel rises higher above the water and it is asserted that the diminution of friction thus produced makes it possible to attain a very high speed. Steering of this strange craft is effected by means of the float, which is provided with horizontal and vertical rudders and a screw propeller. The float is cylindrical in form, large enough to accommodate two steersmen, and carries a periscope. In this use of the vessel its buoyancy is increased by exhausting the air from the space between the inner and outer spherical shells. The boat is submerged by opening valves and allowing this space to fill with water, the auxiliary vessel, or "float," being submerged by a similar method.

The boat is propelled under water by the screw attached to the "float," and the flanged spherical shell does not rotate. If it is desired to stop and take an observation, the clutches which attach the inner shell rigidly to the steel arms are released, and water is expelled from the float, which rises to a position vertically over the spherical vessel, with its periscope emerging from the water, as shown in Fig. 2. An intermediate stage of this, or the reverse evolution, is shown in Fig. 3, while Fig. 4 exhibits the interior of both parts of the vessel and the launching of a torpedo, the vessel being nearly submerged. The torpedo can be discharged either by compressed air or by a small charge of powder. The spherical vessel is entered through its hollow trunnions, the "float" through a low tower with a movable top, resembling that of the usual type of submarine boat.

The advantages claimed for this novel vessel com-

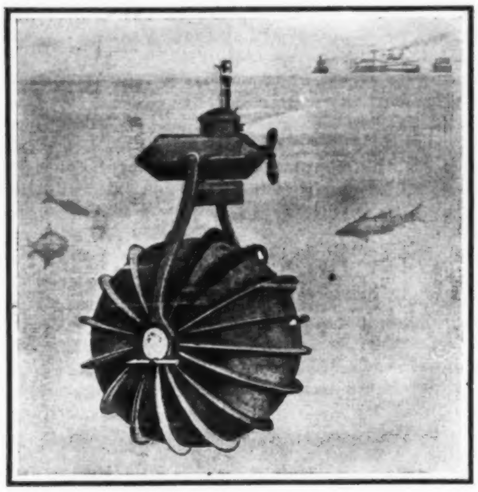


FIG. 2.—THE BOAT SUBMERGED AND TAKING AN OBSERVATION.

prise great speed, stability, comparative invulnerability, and quickness and certainty of evolution of every kind, including turning, diving, stopping under water, and rising to the surface. Very satisfactory results have been obtained in experiments with a large-sized model.—Kriegstechnische Zeitschrift.

THE PROPERTIES OF ORGANIZED MATTER.

A DISTINCTION must be drawn between organized and merely organic matter. The latter is crystallized, of relatively low molecular weight and, even when it is nominally insoluble in water, it possesses a solubility incomparably greater than that of organized substances, all of which are colloids. The unit of organized matter is the grain, which is analogous to the molecule, but is less sharply defined and may contain an indefinite number of atoms, amounting to several thousand. All the properties of these grains are very different from those of the molecules of crystalloid organic matter. Upon these properties the possibility of life, as we know it, depends.

The different varieties of starch grains bear no resemblance to the molecules of sugar, all of which are identical. Even the properties which these various starch grains have in common are not rigorously universal or identical. For example, the starches are distinguished from other organized bodies and from each other by the fact that all of them form glutinous masses, but at different temperatures, which are comprised within certain limits. Again, all of the starches are colored blue by iodine, but to different degrees. A starch grain is a complex body, in which the successive concentric layers have different properties. These layers have not been deposited in identical conditions. Their present state depends upon their past state; in others words, they have a history. The

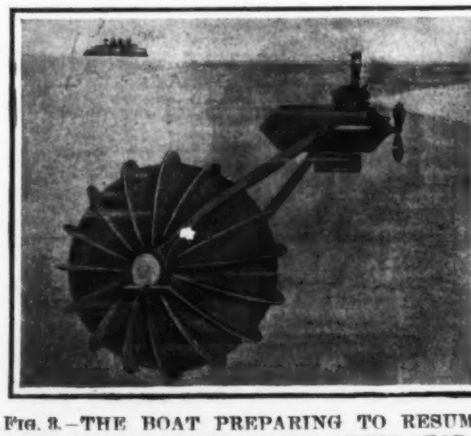


FIG. 3.—THE BOAT PREPARING TO RESUME ITS COURSE UNDER WATER AFTER STOPPING TO TAKE AN OBSERVATION.

characteristic of the strictly chemical reactions of crystalloid substances, on the other hand, is the fact that they depend wholly upon the present state of the system and are not affected by its past history. Hence, in order to be able to construct a starch grain the chemist must know all of these anterior conditions and reproduce them in their proper order. The possibility of such a synthesis is conceivable, but we do not know whether the necessary conditions can be realized outside of the plant, or by means of a mechanism more simple than that of the plant. Even if we admit the possibility of constructing starch grains (which must be less than 1/250 inch in length) and all the other organized substances which enter into the structure of an organic cell, it will still be vastly more difficult to produce a development similar to that of the cell, i. e., to produce life. In order to explain life it appears to be necessary always to go back more or less into the history of the organism.—Le Genie Civil.

THE MUSICAL FLEA.

AT a recent meeting of the Royal Society Dr. A. E. Shipley read, on behalf of Prof. F. J. Cole, a paper upon Tone Perception in *Gammarus Pulex*. The paper pointed out that audition in the lower animals cannot be satisfactorily studied in most cases, since a stimulus produces no response that can be seen or measured. Gammarus, however, when confined in a microscope live box, responds in an energetic and striking manner by flexing its first pair of antennæ under its body. A response can be elicited after the second pair of antennæ has been removed, but not after the removal of the first pair. The instrument generally used to produce the stimulus was a tenor trombone, and the experiments were conducted either on the ordinary laboratory table or on a table specially constructed to filter off vibrations from the ground, and thus to ensure that the

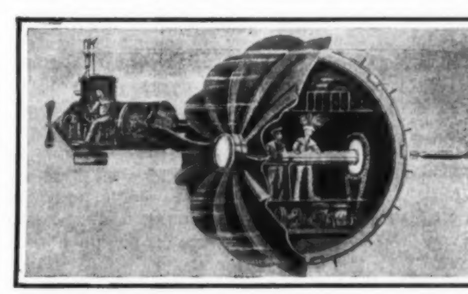


FIG. 4.—LAUNCHING A TORPEDO WHILE THE BOAT IS NEARLY SUBMERGED.

stimulus reached the animal through the air. It was found that Gammarus was most sensitive to the B-flat below middle C, and that its range of tonal sense was so limited that it might almost be adduced as an example of absolute or physiological tonality, i. e., of an animal specially sensitive to one note. Only a small percentage of individuals, however, responded at all, and then, probably owing to fatigue, the power of response soon disappeared. One specimen responded to every note of the trombone. The experiments may be interpreted as either tactual or auditory reactions, if it can be held that these two senses have segregated out in such a simple and true aquatic species as *Gammarus pulex*, and do not merely form a part of an indefinite common sensibility. Prof. Cole's experiments are of great interest, and it may be remembered that Darwin, in his great book on "Earthworms," pointed out that these animals were quite insensible to the sound of a bassoon. Those of our readers who have passed middle age may remember seeing at fairs and such-like occasions an exhibition known as the "Industrious Fleas." One of the industries which these little animals undertook was nominally that of playing in an orchestra, and this was managed by the fleas being tied to small paper chairs which were placed in a ring on a musical box. When the musical box was wound up and set going the fleas waved their legs in a perturbed manner, but this was, we presume, mainly a tactual reaction owing to the vibration of the musical box being transmitted through the lid to the paper chairs, and so to the fleas' bodies.—The Lancet.

THE ELECTRIFICATION OF RAILWAYS.—I.*

AN IMPERATIVE NEED FOR THE SELECTION OF A SYSTEM FOR UNIVERSAL USE.

BY GEORGE WESTINGHOUSE, PITTSBURG, PA.

As an illustration of the wonders of the laws of nature, few inventions or discoveries with which we are familiar can excel the static transformer of the electrical energy of alternating current of high voltage into the equivalent energy at a lower voltage.

To have discovered how to make an inert mass of metal capable of transforming alternating currents of 100,000 volts into currents of any required lower voltage with a loss of only a trifle of the energy so transformed, would have been to achieve enduring fame. The facts divide this honor among a few, the beneficiaries will be tens of millions.

In less than twenty-five years a new industrial and economic situation has been created by the development of apparatus to generate, distribute and utilize electricity. Not less than two thousand million dollars have been invested in plants to manufacture apparatus, in power houses to generate electricity, in lines of copper wire to transmit this mysterious energy, in construction of railways and their equipment, and in the manufacture of products unknown before the advent of electricity.

Large sums have already been spent in the electrification of portions of standard steam railways in England, continental Europe and America, and there is now available a fund of information of inestimable value to guide those charged with the selection of an electrical system for railway operations.

The president of the Institution of Mechanical Engineers, Mr. Aspinall, in his presidential address delivered April 23rd, 1909, placed the railway world under deep obligation for most valuable information upon the electrical equipment and operation of trains of the Lancashire & Yorkshire Railway, of which he is the worthy and skillful general manager. His observations on the effects of low center of gravity and heavy inflexible motor trucks upon the permanent way are especially valuable in that they direct attention to costs which at first were not considered with sufficient care.

Believing unreservedly that the increased capacity of a railway and its stations, the economies of operation, and other advantages will bring about gradually the systematic electrification of steam railways, my wish is that the progress of the art may not be hampered and such electrification of our main lines delayed or rendered unprofitable by mistakes which experience, judgment and foresight may enable us to avoid. It is my intention in this paper to direct attention to the necessity for the very early selection of a comprehensive electrical system embracing fundamental standards of construction which must be accepted by all railway companies in order to insure a continuance of that interchange of traffic which, through force of circumstances, has become practically universal, to the great advantage of transportation companies and of the public. Having been identified with railway operations for over forty years, and with the development of the electrical industry for twenty-five years, I feel that the time is ripe for such a selection unless we are willing to regard with complacency the extension of the existing diversified systems and the creation of conditions which will prevent the general use of the most practical methods of operation. Indeed, the tendency seems to be toward diversity rather than unity, since different types of third-rail construction have been adopted, even for the several continuous-current systems in and about New York city, which renders interchange of cars or locomotives difficult or impossible.

Although the fact clearly show the contrary, there exists a popular impression that the electrification of railways is a simple matter, and that it requires only decisions by boards of directors to insure the immediate substitution of the electric for the steam locomotive. The great difficulty in the electrification of standard railways is no longer the engineering problem of developing a locomotive and an electrical system which will operate trains, but it is a broad question of financial and general policy of far-reaching scope, considering the future electrifications of railways in general as distinguished from isolated cases of limited extent, and requiring a combination of the highest engineering and commercial skill.

GAGE OF TRACK AND INTERCHANGE OF TRAFFIC.

In the first days of railway operation, there was probably no idea of an interchange of traffic involving the use of the engines and cars of one railway upon the lines of another railway. It then made no difference whether the gage of track were 4 feet 8½ inches, the one ultimately selected, or one of a greater or lesser width by a few inches. The gage selected by Stephenson was a practical one, fortunately, since it has become almost universal, with a strong probability that it will one day be absolutely so. Stephenson's successful demonstrations prompted experimenters in other countries, who naturally failed to appreciate the inconvenience and losses which were to follow the adoption of different gages. The general tendency to extend along the line of least resistance made it inevitable that a railway once started upon a certain gage would make no change, and thus there were developed systems of railways with different gages of track. In the early days, too, there were those who believed it to their advantage to establish a gage of track that would absolutely prevent the cars and engines of a connecting line from coming upon their line. In some cases in the United States the difference in gage was, fortunately as it afterwards proved, only 1½ inch, a difference successfully met, for the purpose of interchange of traffic, by the adoption of broad-tread wheels and minor changes in the track construction. In other cases, the gages adopted were 5 feet, 5 feet 6 inches, and 6 feet, and in some of these cases the necessity for through passenger traffic led to the changing of car trucks, at certain important places, so that passengers could be transported through to their destination without changing cars.

In 1878 there were in the United States eleven different gages of railroad tracks in addition to the standard gage of 4 feet 8½ inches. The absolute necessity for uniformity of gage of tracks both in the United States and Canada became so apparent that in due course all of the roads which had gages wider than 4 feet 8½ inches changed to the present standard. Among the remarkable achievements of engineering was the change of the tracks of an entire system of railway of some hundreds of miles within twenty-four hours, this change having, however, required months of preparation. The losses entailed in the change of gage and of equipment have ever since been serious burdens to most of those railways, in that the costs were in most cases covered by capital charges.

It may be conceded that, so far as steam railway operation is concerned, there are now no obstacles to the interchange of traffic in the broadest sense, except in the size of vehicles in certain countries where the cost of changing tunnels and bridges would be prohibitive.

REQUIREMENTS FOR INTERCHANGE OF TRAFFIC.

With these preliminary remarks I feel certain you will agree that to insure interchange of traffic, the fundamental requirements, so far as operation by steam is concerned, with full regard for safety, speed and comfort, are very few in number and are covered by the following:

a A standard gage of track.

b A standard or interchangeable type of coupling for vehicles.

c A uniform interchangeable type of brake apparatus.

d Interchangeable heating apparatus.

e A uniform system of train signals.

The additional fundamental requirements for electrically operated railways are:

f A supply of electricity of uniform quality as to voltage and periodicity.

g Conductors to convey this electricity so uniformly located with reference to the rails that, without change of any kind, an electrically fitted locomotive or car of any company can collect its supply of current when upon the lines of other companies.

h Uniform apparatus for control of electric supply whereby two or more electrically fitted locomotives or cars from different lines can be operated together from one locomotive or car.

Outside of economy in capital expenditure, and economy and convenience in operation by steam or electricity, it matters not whether each locomotive and car and the apparatus upon them differ from every other locomotive and car in size or details of construction, so long as the constructions are operative and the materials employed are used within safe limits.

DEVELOPMENT OF ALTERNATING-CURRENT APPARATUS.

Having acquired a considerable experience in the introduction upon railways of the compressed air brakes and in the development of automatic electro-pneumatic signals, I was led in 1885, because of its general analogy to operations with which I was familiar, to interest myself in the American patents of Gaulard and Gibbs (a Frenchman and an Englishman), covering a system of electrical distribution by means of alternating currents, with static transformers to reduce these currents from the high voltage necessary for economical transmission of electrical energy to the lower voltages required for the operation of incandescent lamps and other purposes.

No inventions ever met with greater opposition in their commercial development than those relating to the generation, distribution and utilization of alternating currents, and it is a matter of record that the opponents of those interested in developing the alternating system even sought, through public meetings and the appointment of commissions, and by various extraordinary means, to influence and prejudice public opinion. Realizing the limitations of the continuous or direct-current system, I became thoroughly convinced that the extended distribution of electricity for industrial purposes could be secured only by the generation of alternating currents of high voltage and their conversion by static transformers into currents of various voltages. Notwithstanding, therefore, the frank disbelief in its practical value by eminent scientific authorities, among them the late Lord Kelvin, I entered actively into the development of the alternating-current system of generation and distribution of electricity which is now almost universally accepted as the ideal.

By 1888 Nikola Tesla had demonstrated the practicability of his induction motors, Oliver B. Shallenberger had perfected his meter for measuring alternating currents, and it had been proved that a direct-current motor with laminated armature and fields could be operated either by alternating or by direct currents. I then became thoroughly imbued with the belief that further invention and discovery would in time make alternating-current apparatus practically universal for almost every purpose.

In 1892 two single-phase motors of about 10 h.-p. were built by the Westinghouse company to determine the possibilities of using alternating current for traction work. These motors were designed for 2,000 alternations per minute and about 200 volts. They were of the series type, with commutators, and had a relatively large number of poles. These were placed upon a car and tested on a short piece of track with very short curves and rather steep grades. There was a transformer on the car on which there were several taps and the voltage was varied by means of a single-pole switches. It was considered at that time that the system would be ideal for locomotive work, but as there were no such projects in view, no large motors of this type were built.

All so-called continuous or direct-current generators really generate alternating currents and transform them by a commutator into continuous current, and such a machine will, by the application of collector rings upon its armature, deliver both alternating and continuous currents. The use of the commutator, however, so limits the voltage that large quantities of power cannot be generated for economical transmission by direct current. A machine so constructed can also receive alternating currents through the collector rings and transform them into direct current. As thus used the apparatus is called a rotary converter. When the supply of alternating current is at very high voltage, there has to be interposed between this supply and the rotary converter a static transformer to reduce the high primary voltage to the permissible lower voltage.

ELECTRICAL SYSTEMS FOR RAILWAYS.

As soon as these qualities of the alternating current had been demonstrated, active minds were directed toward the development of apparatus to meet conditions constantly presenting themselves, among the most important problems being the electrification of railways. In the twenty years that have elapsed, three important electrical systems for the operation of railways have been put into practical operation, all using alternating current in whole, or in part. These systems are:

a. The continuous or direct-current system, usually spoken of as the "third-rail" system, which employs alternating current for transmitting power when the distance is considerable.

b The three-phase alternating-current system with two overhead trolley wires.

c The single-phase, alternating-current, high-tension system with a single overhead trolley wire.

In a notable case of the latter system, namely, that of the New York, New Haven & Hartford Railroad, the

* Read before the American Society of Mechanical Engineers.

motors and controlling apparatus are arranged to utilize single-phase current from an overhead trolley wire at 11,000 volts, and also to be operated by current from the 650-volt third-rail system of the New York Central & Hudson River Railroad, thus making a demonstration of the wonderful flexibility of alternating-current apparatus.

The problem before the officials of the New Haven road was not merely the electrification of a division of a few miles of its track, rendered compulsory by legal requirements, but the selection of a system which would meet the needs of a great railway covering several States and having other congested centers of traffic which it might soon be desirable to electrify. In view of the fact that there had been no considerable demonstration of the single-phase system by actual use, and that the New Haven trains would be obliged to operate upon twelve miles of lines already equipped with the direct-current third-rail system, it must be conceded that the directors and management of the New York, New Haven & Hartford Railroad showed great courage and confidence in the judgment of their experts, and rendered to all other railroads a service of the highest character, when they selected the single-phase system for the electrification of the line mentioned.

The results of the working of the three-phase system in Italy and Switzerland have been very prominently before the world for several years, and its successful use there has been a material factor in the development of confidence in electricity for the operation of railway trains. At the present time, the Italian Government is installing upon the Givoi line, which is a heavy grade branch leading out of Genoa, a service for which thirty-five locomotives, rated at 2,000 h.-p., are now being constructed in Italy. The operation of this much more extensive plant will afford additional valuable information as to the cost of installation and operation, and the advantages of the three-phase system.

RAILWAY MOTORS.

Essential requisites in a railway motor are that it shall start its load and quickly accelerate it to the required speed, and that it shall operate continuously at any desired speed, or speeds. Railway conditions make desirable speeds varying from the slowest to the highest schedule speeds for regular operation, both for the movement of freight and passengers, and for making up time.

The steam locomotive, which is limited in power by its boiler capacity, is capable of continuous operation at any speed up to the maximum, but the maximum speed in a given case depends both upon the length of the train and the grade of the track. It automatically slows down when ascending a grade, so that the actual horse-power developed does not vary greatly at different speeds. The limitation of the capacity of the electric locomotive is not the power available, as is the case with the steam locomotive, but in the capacity of the motors, and is usually fixed by the heating of their coils. An electric locomotive may safely develop for a short time an output which far exceeds its normal continuous capacity. The power and speed characteristics of electric locomotives therefore differ from those of steam locomotives.

The three types of electric motors have certain fundamental differences in speed performance which are important factors in determining the advantages, disadvantages and limitations of the several systems.

THE DIRECT-CURRENT MOTOR.

The characteristics of the direct-current series railway motor are well known. It automatically adjusts its speed in accordance with the load, running more slowly if the weight of the train be greater, or the grade steeper. The speed with a given load, however, is definite; it is dependent upon the voltage applied to the motor and cannot be readily varied. It is true that the speed can be decreased by inserting a resistance in the motor circuit, but this is wasteful and is inadmissible except as a temporary expedient. It is true also that the motors may be connected in series, thus dividing the pressure between two motors, and thereby reducing the speed one-half; or if among four motors, to one-quarter speed. As the system of current supply involves a fixed voltage, it is obvious that for emergencies no speeds much above the maximum speed determined in the construction of the motor can be obtained. Furthermore, on account of the high cost involved in maintaining a practically constant voltage throughout the system, the voltage supplied to the motors often decreases considerably at the end of long lines, at the time of heavy load, thereby further reducing the speed attainable. It often happens in railway service that a locomotive should be operated somewhat above the normal speed, and sometimes a locomotive designed for freight service has to be pressed into passenger service. In such cases the speed with the direct-current locomotive would be considerably less than that necessary to maintain the schedule speed. A special form of field control can be used, in certain cases, for varying the speed, although this has so far been utilized to a very limited extent. (To be continued.)

THE EARTH AND COMETS' TAILS.

THE EVENTS OF MAY 18-20, 1910.

IN spite of the unreserved predictions of astronomers, the earth did not pass through the tail of Haley's comet on May 18-19th, nor subsequently. The tail as seen in the morning sky, previous to the transit of the comet across the sun's disk, appeared like a long and straight beam of light stretching from the horizon to Aquila. It was noticed from day to day that the tail was practically fixed in position in the sky. We rather expected the tail to get nearer to Venus and Saturn as the comet approached the ecliptic, but it remained stationary. On the morning of transit, May 18-19th, the tail was unchanged, but a second branch to the south was now noticed. It joined the northern branch to the east of the Square of Pegasus. Unfortunately, this southern branch was near the zodiacal light, and only distinguished from it with difficulty.

Both these tails were seen morning by morning, including this morning (May 22nd, Civil day), but they have diminished in brightness, and were difficult to see. Further observation of these will be impossible, because of the moon remaining above the horizon until after dawn during the next ten days. The whole eastern horizon, where the tails meet and where the zodiacal light is, was suffused with a dim and indefinite glow, which was particularly noticeable on May 18-19th and 20-21st. This glow was not so definite in boundary as the zodiacal light. When the comet was seen on the evening of May 20th we were surprised to see it had the ordinary tail pointing away from the sun as usual. It had been noticed for several days that in the neighborhood of the sun the sky was not so blue as usual, but this was the case even a week before the transit, and is probably merely a meteorological phenomenon. This brief summary of the facts will suffice here; the observations in detail will be published elsewhere.

We have now to explain the reason why the earth did not pass through the tail of the comet, and why the tail broke up so that some of it was left in the morning sky, where it remains, and is slowing losing its luminosity, and some (or another tail) appeared in the evening sky. It is well known that a comet under the sun's radiant action (I do not attempt to define it more closely) expels corpuscles towards the sun which the sun repels, and these luminous corpuscles form the tail. This process goes on even when (as in the case of Halley's comet) the distance between the comet and the sun exceeds the distance of the earth from the sun. If the nearer planets do not show tails it is because these corpuscles have been shed by the planets ages ago. In short, a comet and a planet under the radiant action of the sun, and the sun itself, all repel these corpuscles. This being so, it is impossible for the earth to go through the tail of a comet—it simply repels the tail, and, as a consequence, instead of a passage through it, a disruption near the time of passage must occur, one part being left in the (in this case) morning sky, whilst a new one is developed in the evening sky. Here I may remark that on the evening of May 20th the measured length of the new tail was 19 deg., on May 21st 32 deg., and on May 22nd it was 40 deg.

Again, the earth is bombarded with meteorites, which are also throwing off corpuscles. These will be repelled by both earth and sun, so that if we look at the part of the sky opposite to the sun we should, and do, see the faint tail thus formed which is known as the Gegenschein. This simple theory explains all the facts of observation, and, if it is correct, will save nervous individuals some worry when the next near approach of a comet's tail is imminent.—R. T. A. Innes in Nature.

NEW FACTS ABOUT THE PLANETS.

IN December, 1909, Sir George Darwin presented to the Royal Astronomical Society the results of his four years' researches on the possible forms of periodic orbits that can be described by a planet under the influence of a very great disturbing force. Among these orbits, which bear no resemblance to ellipses, are the trajectories of two bodies which are violently separated and subsequently come together again. In reality, the only permanent member of the solar system which has not an approximate elliptical orbit is the eighth satellite of Jupiter, which has a retrograde motion and a period of about two years, but does not describe a closed orbit because of the magnitude of the solar perturbation. Cowell and Crommelin have calculated its path from quadrature to quadrature but its course cannot be predicted for long periods.

The search for an ultra-Neptunian planet has been diligently carried on by Gaillot in Paris, Lau in Copenhagen, W. H. Pickering in America and Forbes in England. Dr. Forbes's method is based on the supposed capture by the hypothetical planet of a number of comets at their aphelion distances of about 100 astronomical units from the sun. Gaillot, Lau and Pickering deduce the position of the unknown planet from the residual perturbations of Uranus. The four results agree fairly well but the planet has not been found. Pickering intends to continue the search this year.

T. J. J. See has published a theory of cosmogomy which supposes the planets to have been captured by the sun in its course and to have been brought into nearly circular orbits in nearly coincident planes by the influence of a resisting medium.

G. and V. Fournier observed Mercury with great care in September but failed to detect any change in the appearance of the planet in two hours. This is an additional evidence in favor of slow rotation.

At the meeting of the British Association some very fine photographs of Jupiter were exhibited by Lowell.

Many new asteroids of no especial interest were discovered in 1909, several of them accidentally in the search for Halley's comet and new satellites. Eros continues to form a brilliant exception in this group, because its proximity to the earth furnishes the best known means of determining the solar parallax. Hinks has discussed the vast mass of observations and photographs made at the opposition in 1900-1. He finds that the uncertainty in the value 8.807 seconds is confined to the last decimal. The only cause of systematic error still to be feared is a difference between the mean brightness of the comparison stars and that of Eros. The international congress, which met in April, 1909, at Paris, has already begun preparations for the observations in 1931 and has assigned to Stroemgren the calculation of the ephemeris and the perturbations of Eros until that date.

TANTALUM DENTAL INSTRUMENTS.

DEPUTY CONSUL-GENERAL ARCHIBALD B. DORMAN furnishes the following information concerning the manufacture of tantalum dental instruments, recently established in Berlin:

Many advantages, besides lower prices, are claimed for tantalum dental instruments over the steel instruments, which they are intended to supersede, viz., hardness; freedom from effects of bases and acids, except fluoric acid; and capacity to withstand a temperature of more than 400 deg. C. (752 deg. F.). American dentists say that the tantalum instruments do not rust when left exposed to the air, but retain their polished surfaces, besides proving more lasting than the steel instruments. They can be cleaned by being washed in soda and disinfected by being boiled in water containing soda. In working with phosphate and silica cements and amalgams, tantalum instruments have special advantages; they are not affected by iodine, etc. They may be used, in working root canals, with trikreosol acids, where steel can not be used.

Artificial Frostwork on Windows.—Epsom salts, 1 part, is dissolved in 2 parts beer and the window pane evenly coated with the mixture, by means of a sponge. If the windows are not jarred they will be covered with crystals, deceptively similar to the ice blossoms.

IS THERE ABSORBING MATTER IN SPACE?*

AN EXAMINATION OF A GREAT NEBULOUS REGION.

BY E. E. BARNARD.

WHILE photographing the region of the great nebula of ρ Ophiuchi (which I had found with the Willard lens) at the Lick Observatory in 1893, the plates with the small lantern lens (1½ inches diameter, also attached to the Willard mounting) showed a remarkable nebula involving the 4.5 magnitude star ν Scorpii (Plate I). It had not been noticed on the Willard lens photograph, where it was very faint and near the edge of the plate. The discovery of this object therefore is due to the small lantern lens.

Roughly this nebula is bounded by the figure formed by the following places (for 1855.0):

	α		δ	
	h.	m.	deg.	m.
	15	59	−18	20
	16	4	−18	0
and	16	10	−21	00
	16	16	−18	50

In its fainter portions it involves to the southeast the stars B. D. —19°.4357, —19°.4359, and —19°.4361. The last two are in a dense nebulous mass in which on the north following side close to the stars are a thin dark lane and a narrow strip of brighter nebulosity. These two stars are joined to —19°.4357, which is itself nebulous, by a thin thread of nebulosity which is well shown in Plate II A. North and following these objects are dark regions where there are apparently very few stars. The expanses of this great nebula reach to, and in a feeble manner connect with, the great nebula of ρ Ophiuchi.

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PLATE I.—GREAT NEBULA OF NU SCORPII.

10-inch lens, 1905, April 4th, 19h 25m to 24h 20 m G. M. T. Scale: 1 inch = 49′. The plate covers 3°.9×4°.6.

The greatest interest in this nebula, however, lies in the fact that it seems to show a veiling of the stars in certain of its portions. Especially is this noticeable at its northern and western end, near the stars —17°.4511, —17°.4502, and —18°.4240. It is quite evident that the thinning out or dimming of the stars in this region, that are apparently in the nebula, is not due to a chance vacancy. The line of demarkation between the rich and poor portions of the sky here is too definitely and suddenly drawn by the edges of the nebula to assume the appearance due to an actual thinning out of the stars. It looks, where this part of the nebula spreads out, as if the fainter stars were lost, and the brightness of the others reduced at least a magnitude or more. This remarkable feature of the nebula is very important to a proper understanding of the region of the great nebula of ρ Ophiuchi, which is five degrees south of ν Scorpii. In the region of ρ Ophiuchi there is every appearance of a blotting out of the stars by the fainter portions of the nebula, but from its complicated and irregular form the hiding of the stars is not so clearly evident as in the case of the ν Scorpii nebula. At present we have no means of determining whether a nebula is transparent or not. The assumption has always been that they are transparent like the comets. The proof of the transparency of comets is easy, but for obvious reasons there can be no similar proof with respect to the nebulæ. I think in the present case, however, that the nebula of ν Scorpii is shown to be at least partially transparent, but the absorption of the light of the stars behind it must be considerable. The picture is quite conclusive evidence that the nebula is nearer to us than the general background of stars at this point. This fact, unfortunately, is not so evident in the reproduction as it is in the original, an inspection of which would at once lead to the above conclusion.

In connection with the present subject I would call attention to a paper of mine in Astrophysical Journal, 23, 144, March, 1906, which describes a very intricate and straggling nebula in this region, connecting the stars π and δ Scorpii. I believe this object will ultimately be found, with more sensitive plates and longer exposures, to be connected with the ν Scorpii and ρ Ophiuchi nebulosities. The accompanying chart, which covers parts of the constellations Ophiuchus, Scorpio, Libra, and Lupus, is intended to show the relation of these various nebulosities to each other. There is strong evidence that they are but the brighter parts of one enormous nebula that covers all this region. I have indicated only the brighter portions of these nebulosities, especially in the case of ρ Ophiuchi, for that nebula extends in a strongly marked manner for some distance to the east and can be traced for at least 5° in α and 6½° in δ. Indeed I am convinced that all this region as far east as θ Ophiuchi and beyond is affected with this diffused nebulosity.

The ρ Ophiuchi nebula is far more remarkable than that of ν Scorpii. Indeed I do not think there is a finer nebula in the entire sky. Even in comparison with the great nebula of Orion in some respects it has a deeper interest because of the aspect of the sky near it. It is impossible adequately to describe in detail its extraordinary nature and that of the surrounding region. The reproduction falls far short of doing justice to this subject, though it shows the brighter parts of the nebula fairly well. The dark lanes which run eastward from it contain very striking black markings, especially the northern one of the two. To me these singular dark features are of as much importance as the bright portions of the nebula, but it has been impossible to bring them out, in the half-tone. The picture shows, however, the striking absence of stars in the space occupied by the main portions of the nebula. To all appearance, the great nebula is located in a hole in a very dense part of the Milky Way, from which vacant lanes extend far to the east. Besides the two main condensations, σ Scorpii is involved in a very strong and irregular condensation which is marked by a considerable amount of detail and which spreads in a faint diffusion for several degrees to the south. In addition to the main great condensations there is another one, equally remarkable, 1° due south of ρ at the star C. D.—24°.12684. This presents a very singular and striking appearance. From the star as a center issue four bright whorls of nebulosity, which are each about 20′ or 30′ long, the two running north and south being the longest. About 14′ north and slightly east is a singular U-shaped dark marking that is so distinct as to appear almost like a defect. Immediately following this condensation is a dark whirlpool appearance which is formed by the beginning of the vacant lanes running to the east.

The two main and largest condensations lie, one, about the triple star ρ Ophiuchi, and the other, equally important, precedes it to the west about 30′. This latter does not seem to center at any particular star. These condensations are separated by an irregular dark rift 20′ to 30′ long, which runs north and south. North of ρ the nebula assumes a beautiful ribbed appearance which is but feebly represented in the half-tone. The star 22 Ophiuchi lies between two diverging strips of nebulosity, the northern and upper strip curving around the star. This star and the nebulous strips singularly resemble a human eye, from which fact I have called it "the eye." Waves of nebulosity extend to and beyond Antares, diffusing as far south as τ Scorpii. At its upper edge this plate (Plate II A) shows the three nebulous stars which are near the lower left-hand corner of Plate I. It also shows a portion of the nebula of ν Scorpii about ¾ inch or 19 mm. (1°8′) to the west of these stars. Part of the illumination in the extreme upper right-hand corner of Plate II A is due to the reproduction. The portion of the great ν Scorpii nebula which is shown at this point is readily made out (because of its great intensity) 0.9 inch from the right-hand outer edge of the block and 1.1 inches from the upper edge. The rest in this corner is unreal. The diffused nebulosity south of Antares is relatively too bright in the half-tone, though it is real.

The star n (which is C. D.—24° .12698) is 0.41 inch north and 0.25 inch east of 22 Scorpii. It has a narrow strip of nebulosity extending west and south from it for about 6′. This is noticeable on Plate II A.

Among the most remarkable features of this marvelous region are the vacant lanes or streams, pre-

* Republished from the Astrophysical Journal.

LIST OF STARS REFERRED TO ON THE CHART.

Bonner Durchmusterung, Epoch 1855.0.

	No.	Mag.	α	δ
	Degs.		h. m. s.	Degs. m.
b	—18 4240	7.5	16 0 39.1	—18 36.4
c	—17 4502	6.5	16 1 34.4	—17 57.1
ν Scorpii	—19 4333	4.5	16 3 33.9	—19 4.4
d	—17 4511	7.3	16 3 40.6	—17 51.0
e	—21 4305	7.0	16 5 9.4	—21 1.5
f	—20 4444	6.8	16 5 56.9	20 43.8
g	—20 4454	6.8	16 8 26.8	—20 56.2
h	—19 4357	6.0	16 10 38.3	—19 51.5
k	—19 4359	7.7	16 11 36.3	—19 41.9
l	—19 4361	7.3	16 12 0.8	— 9 45.7
ψ Ophiuchi = m	—19 4365	5.0	16 15 37.3	—19 4.6

Cordoba Durchmusterung, Epoch 1875.0.

	No.	Mag.	α	δ	
	Degs.		h. m. s.	Degs. m.	
χ Lupi	—33 10754	4.2	15 43 1.8	—33 14.7	
π Scorpii	—25 11228	3.4	15 51 18.0	—25 45.3	
δ Scorpii	—22 11292	2.7	15 52 57.1	—22 16.2	
13 Scorpii	—27 10841	5.3	16 4 36.6	—27 35.7	
σ Scorpii	—25 11484	3.4	16 13 37.2	—25 17.1	
	—24 12684	8.0	16 17 52.1	—24 10.3	The star with the 4 whorls
ρ Ophiuchi	—23 12861	4.8	16 18 6.1	—23 9.2	
Antares	—25 11359	1.4	16 21 46.0	—26 8.9	
22 Scorpii	—24 12695	5.5	16 22 37.6	—24 60.5	
n	—24 12698	9.3	16 24 7.4	—24 8.8	
τ Scorpii	—27 11015	3.2	16 28 6.8	—27 57.2	
p	—24 12765	6.3	16 34 2.4	—24 13.5	

viously referred to, extending to the east. The lower or southern of these, which is ½° broad, is the strongest marked. Its full extent is beautifully shown in Plate II B, which overlaps Plate II A. Its edges are very clearly defined for about 7°, after which it becomes broken and shattered and ends 10° to the east in an irregular group of small holes. The northern and shorter of the two most conspicuous lanes is marked for about 2° with very black, irregular and sharply defined rifts and perforations which unfortunately are lost in the reproduction. For a history of the discovery of this great nebulous region see Popular Astronomy, 5, 227, September, 1897.

I have at other times called attention to the fact that the real connection of this great nebula with such bright stars as σ Scorpii, ρ Ophiuchi, and others, and its connection with the substratum of small stars of the Milky Way, in which the lanes occur, was a proof of the actual smallness of the stars forming the groundwork of the Milky Way at this point and elsewhere. This must necessarily be true, for the connection with the bright and small stars would imply that the small stars are roughly as near to us as the large ones in this part of the sky, and hence relatively small bodies. If, however, the connection with the small stars is only apparent and the lanes and holes are due to absorbing media between us and the Milky Way, the supposition of smallness would not hold true.

While speaking of these strange dark forms, such as are connected with the ρ Ophiuchi nebula, and which are so wonderfully shown on the photographs of the region of θ Ophiuchi (Astrophysical Journal, 9, 157, 1899, and Popular Astronomy, 14, 579, December, 1906), I would call special attention to an object of this class which has been shown on a number of my photographs for the past fifteen years or more. It is a small black hole in the sky, very much like a black planetary nebula. It is round and sharply defined. Its measured diameter on the negative is 2′.6. The position is closely:

$$1875.0\ \alpha = 18h.\ 25m.\ 31s.,\ \delta = -26°\ 9'$$

On account of its sharpness and smallness and its isolation, this is perhaps the most remarkable of all the black holes with which I am acquainted. It lies in an ordinary part of the Milky Way and is not due to the presence or absence of stars, but seems really to be a marking on the sky itself.

If these dark spaces of the sky are due to absorbing matter between us and the stars—and I must confess that their looks tempt one to this belief—such matter must in many cases be perfectly opaque, for in certain parts of the sky the stars are apparently entirely blotted out. It is hard to believe in the existence of such matter on such a tremendous scale as is implied by the photographs. As to its nature if it does exist, it must in some way be related to the nebulæ, for we find them in most cases to be intimately connected. Is it an ultimate condition of nebulous matter or is it something wholly different from the ordinary nebulosity of the sky?

To those who may be interested in the subject of possible masses of dark absorbing matter in space in connection with visible nebulosities I would refer to a paper of mine, "On a Nebulous Groundwork in the Constellation Taurus," Astrophysical Journal, 25, 218, April, 1907, where a system of dark lanes and holes in Taurus is shown to exist in the sky independently of the stars.

The accompanying photographs were made by me with the 10-inch Brashear lens of the Bruce photographic doublet which, through the courtesy of Prof. Hale, was temporarily stationed at the Solar Observatory of the Carnegie Institution on Mount Wilson, California, in 1905.

As will be noticed in the photographs the great lane extending to the east from "the eye" on Plate II A and continued in Plate II B runs almost due east and west. While at the Lick Observatory, I once showed a plate of this region to Prof. Tucker, who had such a large part in the making of the Cordoba Durchmusterung. He said that this picture made

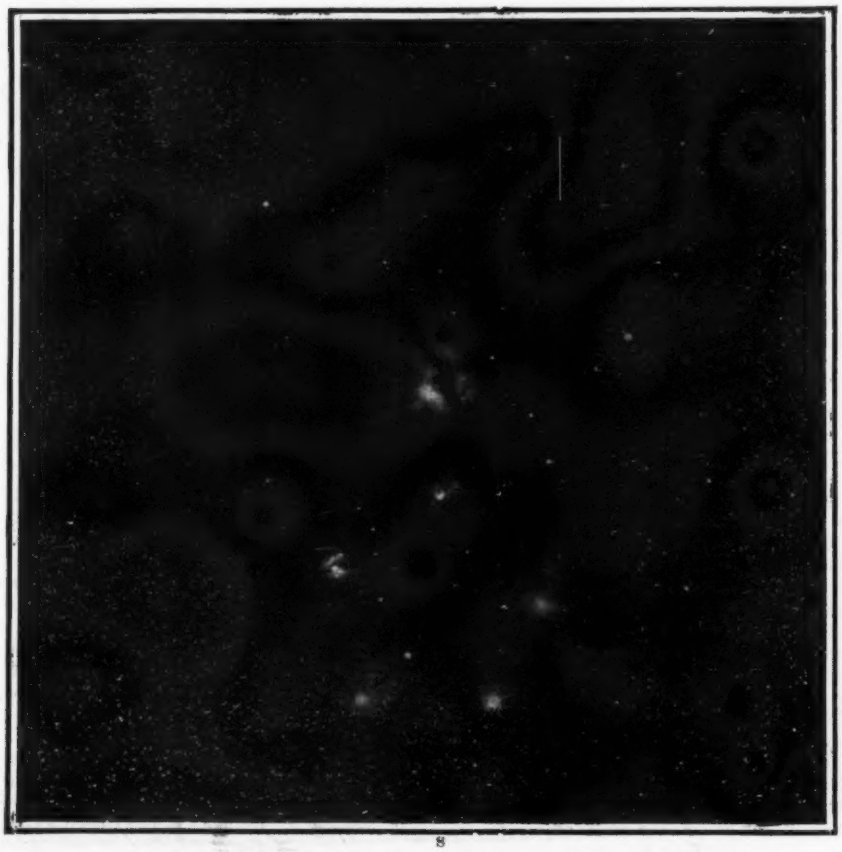

PLATE IIA.—GREAT NEBULOUS REGION OF RHO OPHIUCHI.

10-inch lens. 1905, April 5th, 19h 45m to 24h 15m G. M. T. Scale: 1°=16.7 mm. The plate covers 7°.7×7°.7.

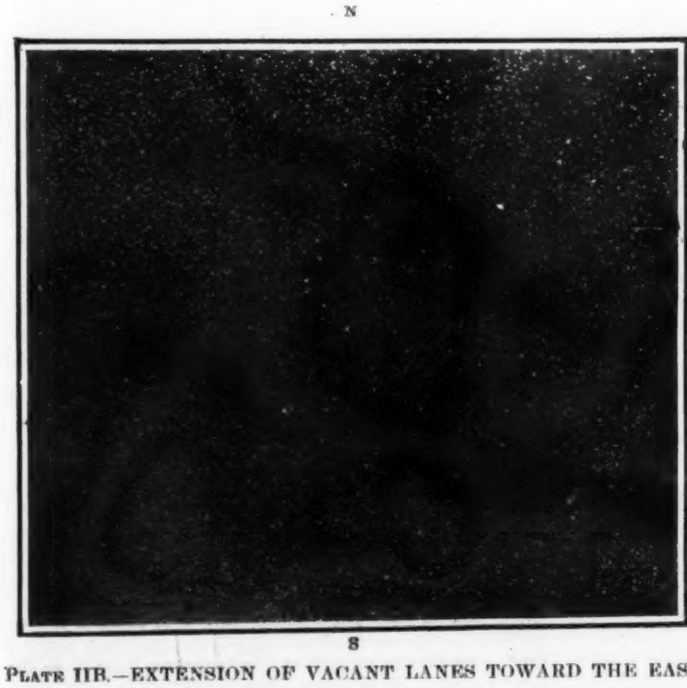

PLATE IIB.—EXTENSION OF VACANT LANES TOWARD THE EAST.

Plates overlap slightly. Center of plate at α=16h 45m, δ=22° south. 10 inch lens. 1905, June 3rd, 17h 0m to 21h 0m G.M.T. Scale: 1°=13.5 mm. The plate covers 7°.6×6°.7.

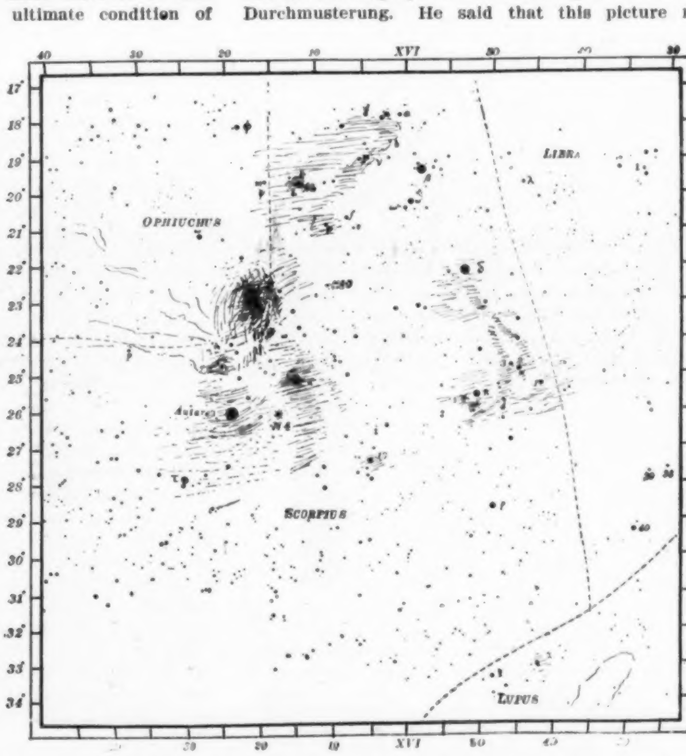

CHART OF THE GREAT NEBULOUS REGION.

clear an experience in his observing work at Cordoba that had always been a puzzle to him. One night he had set his telescope in the region a little north of Antares and prepared to record the transits of stars as they passed through the field. Presently no stars came into the field of the telescope. After watching for some time he finally concluded the sky had clouded over, but on looking out he found it clear. He returned and watched a long time before any stars appeared. His telescope had been pointed to this lane and nothing but blank sky had passed.

Yerkes Observatory, November 30th, 1909.

THE INDIA-RUBBER INDUSTRY.—I.*

PAST, PRESENT, AND FUTURE.

BY PHILIP SCHIDROWITZ, PH.D

Introductory and Historical.

The foundations of the rubber industry were laid considerably over a century ago, yet it must, as an industry proper, be regarded as of a comparatively modern and recent origin. Although Samuel Peal in 1791 patented a process for waterproofing cloth by spreading it with hot rubber, Thomas Hancock, of London, and Charles Macintosh, of Manchester, are generally regarded, in conjunction with Charles Goodyear, of New Haven, Conn., as being the actual founders of the industry. Macintosh in 1820 produced waterproof garments by a practicable process, and at about the same date Hancock invented a masticating machine and process, thus introducing the manufacture of rubber sheet and much improving the method of making "solution." It was not, however, until after the process of vulcanization by the combined action of sulphur and heat had been discovered by Goodyear in 1839, and independently by Hancock about 1844, that the rubber industry showed signs of becoming of great importance. In 1846 Parkes found that India rubber may be vulcanized in the cold by the action of sulphur chloride suitably diluted, but this process is only applicable to goods of very moderate thickness. The influence of the discovery of "vulcanization" on the development of the rubber industry may be judged by the following figures, representing tons of crude rubber imported into the United Kingdom—1830, 23 tons; 1850, 381 tons; 1870, 7,656 tons; 1890, 13,200 tons; average 1904 to 1908, 29,389 tons. Only a very small proportion of the total passes to the consumer in the unvulcanized state.

Production.—At the present day the total production of raw rubber is probably between 70,000 and 75,000 tons, broadly distributed as follows: Brazil, Peru, and Bolivia, 40,000 tons; other South American countries, Mexico and Central America, 7,000 to 8,000 tons; Africa, 17,000 to 20,000 tons; Ceylon, Malaya, Java, Sumatra, and Borneo,† 4,000 to 5,000 tons; miscellaneous, 1,000 to 2,000 tons.

Consumption.—The most important rubber consuming countries are the United States, the United Kingdom, Germany, and France. Italy and Russia also import and manufacture considerable quantities. As a rough approximation it may be said that the United States consume one-third of the world's rubber, the United Kingdom and Germany between them (in approximately equal shares) another third, and other countries the remaining third.

The Industry in the United Kingdom.—The following figures will give a general idea of the importance of the rubber industry in the United Kingdom.

Imports of Rubber (1908).

From—	Quantity cwt.	Value £
Brazil	300,032	5,331,842
Peru	29,622	518,885
French Colonies	58,159	553,615
Other Foreign Countries	112,085	831,819
(Total Foreign)	499,898	7,236,161
British Possessions	75,168	1,135,044
Total 1908‡	575,066	£8,371,205
do. in 1907	667,294	£10,834,759

Of the total imports, rather more than one-half are re-exported, the average figures for the past five years being:

I. Exports of Raw Rubber.

From—	Quantity cwt.	Value £
Average imports, 1904–1908	587,781	9,302,990
Average re-exports, 1904–1908	334,129	5,858,488
Balance retained for consumption	253,652	£3,444,502

II. Manufactured Goods.

	Exports (1909). Value £.	Imports (1908). Value £.
Miscellaneous goods	1,576,000	482,644
Boots and shoes	205,668	123,381
Waterproofed goods	295,184	6,825
Rubber covered cables, other than telegraph and telephone cables	289,342	103,230
Telegraph and telephone cables	744,140	125,087
Total	£3,110,334	£841,167

There are no published figures on which an estimate of the value of the manufactured articles consumed in the home trade can be based with any certainty, but it may be safely placed at not less than ten millions sterling, assuming normal rubber prices.

The India rubber industry as a whole may be conveniently and naturally subdivided into three sections, namely, I. The production of crude rubber; II. Manufacture of articles from and with the aid of the crude material; III. Treatment and utilization of waste rubber.

India rubber is contained, in the form of an emulsion, in the latex or milk of the laticiferous system of various plants. It also occurs, but not frequently, in the solid state, as a deposit in the woody fiber of certain species, for instance in the Guayule shrub (*Parthenium argentatum*). The laticiferous system* of most rubber bearing species lies between the outer bark and the cambium. By cutting through the outer bark and into the latex cells the latex may be obtained as a white to cream-colored, more or less viscous liquid. In former days this operation of "tapping" was carried out in a very rough and ready fashion, resulting in injury to the wood and so to the life and yielding capacity of the tree. As regards the "native" or "wild" rubber from large tracts of South and Central America and from Africa this still holds good, since under present conditions of collection, adequate supervision of the natives and methodical working is out of the question. For the correct tapping of a tree, the following factors are of cardinal importance, namely (*a*) the age and species of the tree; (*b*) the method of making the cut; (*c*) the disposition of the cuts and the general contour of the cutting system; (*d*) the season; (*e*) frequency of tapping; (*f*) methods of collection.

Occurrence of India Rubber Bearing Species.—Rubber bearing species are indigenous to considerable tracts of the tropical and sub-tropical zones. Favorable conditions are a moist climate with high and equal temperatures and a fairly copious rainfall. Although the nature of the soil is of importance, certain species thrive well in soils which would be regarded as poor for planting many other tropical products. Rubber species are very numerous, but the following are of greatest industrial importance:

1. *Hevea Braziliensis* or Para rubber. This is indigenous chiefly to the area watered by the Amazon and its tributaries. It has been almost exclusively employed in the plantations of Ceylon and Malaya, and largely in Sumatra, Java, Samoa, etc.

2. *Ficus elastica* or "Rambong" is indigenous to Burmah, Ceylon, Malay, Java, India, etc. It has been planted to some extent in the Eastern Dutch colonies and in some parts of the German possessions (New Guinea, etc.). Other *Ficus* species are found in Africa and South America.

3. *Funtumia elastica.*—Indigenous to many parts of Africa, planted experimentally in Uganda, the Cameroons, etc.

4. *Landolphia* species occur profusely in many of the African rubber districts, and yield a considerable proportion of the crude product exported from Abyssinia, the Congo, and from the West and East coasts.

5. *Castilloa elastica.*—The natural rubber *par excellence* of Mexico and Central America. It has been largely planted in Mexico and experimentally elsewhere.

6. *Manihot Glaziovii.*—Indigenous in the State of Cearà (Brazil). Planted experimentally in the East, the Cameroons, etc. Other rubbers of some technical importance are Guayule (*Parthenium argentatum*), the *Sapium* varieties, the *Hancornia* species and resinous rubbers such as *Dyera costulata* or "Jelutong."

Quality and General Attributes of Different Species.—There are very marked differences in the quality of various rubbers, attributable partly to the inherent properties of the various latices and partly to the methods of collection and preparation. Two main factors determine the value of a rubber, namely, its chemical purity and its physical properties. The chief impurities are moisture, resins, proteins, ash, matters insoluble in rubber solvents, and such adventitious impurities as mechanically admixed earth, bark, etc. In regard to physical properties the main considerations are strength and vulcanizing capacity.

Differences Due to Inherent Properties of the Latex.—There is, in regard to chemical composition, in the narrower sense of the term, no very great difference between the latices derived from the more important species; but the physical properties of rubbers prepared from the main species appear to exhibit wider differences than do chemical properties, but it is probable that improved methods of preparation will tend to minimize these differences also. The best of the *Funtumia* and *Landolphia* species seem to show the greatest mechanical strength, then follow the *Hevea* and *Ficus* species, and then the *Manihot*, *Castilloa*, and *Sapium* species, although some would perhaps place *Manihot* nearer the head of the list. The differences in regard to physical and physio-chemical properties between the various species are of considerable interest, inasmuch as it would appear from the work of Harries and Gottlob that the complex caoutchouc molecule in some of the African varieties (probably *Landolphia* and *Funtumia* species) is not identical as regards complexity and disposition of the simple molecules with the molecule of the *Hevea* species. In splitting the ozonide derived from *Hevea* rubber certain quantities of leavulinic-aldehyde and leavulinic acid were obtained. The fission products derived from the African species and also from gutta percha, were constant in quantity relatively to one another, but the relation of aldehyde to acid was practically the reverse of that observed in the case of the *Hevea* derived ozonides. There are two main factors which must be taken into consideration in connection with the physical properties of pure caoutchouc. In the first place there may be differences in regard to the molecular complexity, i. e., the state of polymerization of the molecule itself, and secondly, differences in regard to the colloidal state of the rubber particles, that is, as Spence has recently pointed out, the differences of physical aggregation. These differences may well occur even in rubber of one and the same species. My own work on the viscosity of rubber solutions is confirmatory of the view that from one or several of the reasons given there are specific differences in regard to the actual "caoutchouc" contained in *Hevea*, *Funtumia*, *Castilloa*, and *Sapium* varieties.

Anyone inspecting the various forms of rubber emanating from Africa, Asia, and tropical America, would scarcely believe that most of these are prepared from latices which if properly treated would yield rubbers differing little in commercial value from fine hard Para on the one hand, or the best plantation products on the other. It is mainly due to the work of the chemist, stimulated by the rise of the plantation industry, which in its turn is mainly due to the efforts of economic botanists, that this change in our views and this important addition to our knowledge has come about.

Differences Due to Methods of Preparation.—The bulk of the raw rubber is still prepared in a very crude manner, and this is likely to be the case for some time to come. Practically all "wild" rubbers (rubbers prepared by the natives of the rubber regions without skilled white supervision) contain in addition to a considerable proportion of moisture, a varying quantity of mechanical impurities. Such rubbers have to be thoroughly cleaned before they can be used in the factory. The loss which native or "wild" rubbers show after this process has been completed, generally varies from

* Read before the Society of Chemical Industry.

† This does not include inferior grade (very resinous) rubbers, such as "Pontianac" or "Jelutong." The annual production of these is probably some 20,000 to 30,000 tons, the United States alone importing some 12,000 tons annually.

‡ 1908, owing to the American financial crisis, was an abnormal year; the totals for the preceding year are therefore also given.

* The laticiferous system is quite distinct from and must not be confused with the cell system bearing the ordinary sap.

10 to 50 per cent or even more. Frequently native rubbers are willfully adulterated with sand, stones, and dirt, not to speak of admixture with inferior rubbers. The foregoing applies chiefly to African and native Asiatic rubbers, for the South American rubbers are, on the whole, better prepared, many of those from the valley of the Amazon being of remarkably fine quality. These rubbers have been, ever since the rubber industry has attained to considerable proportions, a standard of quality, and prices of pure plantation rubbers are still preferred to fine hard Para, as a standard. The Para rubbers are prepared by coagulating successive films of latex round a core by the combined action of heat and wood smoke. In this way the whole of the non-rubber substances contained in the latex are incorporated.

The Plantation Industry.

Perhaps the most important occurrence in the rubber industry since the discovery of the process of vulcanization is the foundation and development of plantations. In 1875 Wickham was commissioned by the Indian government to obtain from the Amazon valley a supply of *Hevea B.* seeds, and from these and from small quantities obtained from other sources, substantially the whole of the 60 to 100 million trees now growing in the East have been raised. In 1876 the first large batch of seeds was planted in Ceylon, but the following twenty years constituted a purely experimental period, and it was not until some years of the present century had passed that planting on a really industrial scale commenced. The evolution of the industry may be gaged by the following figures:

*Approximate Acreage under Rubber in Ceylon.**

	Acreage.
1890	300
1895	550
1898	1,250
1904	11,000
1907	150,000
1910	190,000

The following is an estimate of the total acreage under planted rubber in various parts of the world.†

Country.	Acreage.
Ceylon	190,000
Malay Peninsula	250,000
Java, Sumatra, and Borneo	90,000
India	25,000
German Colonies	38,000
Mexico, Brazil, Africa, and West Indies	100,000
Total	693,000

From the experience gained so far, 200 to 250 pounds to the acre appears to be a safe estimate of yield from young, but not immature trees, planted under reasonably favorable conditions. During 1909 the Eastern plantations exported roughly 4,000 to 4,500 tons, of which 2,800 came from Malaya.

Plantation Methods.—Wild rubber is generally collected from scattered trees as a rule in forest regions inaccessible except to the natives of the district. In most cases, therefore, skilled superintendence of collection of the latex and preparation of the rubber is out of the question. The planter is able, under favorable circumstances, to produce 250 pounds of pure, dry rubber from a single acre of land, whereas the native collector in the forests of Africa and South America may have to scour 40 or 50 acres, if not more, to obtain the same quantity of, in many cases, an extremely inferior product. The tree which is most generally, in fact, in the East almost exclusively, planted at the present time, is *Hevea Braziliensis*, and it has been found possible and profitable to tap this tree at the end of five years. It would be desirable that tapping should be deferred say till the sixth year in most cases, for early tapping produces a comparatively inferior rubber, and is detrimental to the tree. The question as to whether, assuming tapping is conducted in a reasonable manner, the tree may be tapped indefinitely for a successive number of years may be answered in the affirmative, for there are trees in the various botanic gardens in the East which have been successively and successfully tapped for some thirty years or more, and which show no apparent injury.

Cost of Production.—There are two main factors to be considered in this connection, (*a*) cost of bringing into bearing; (*b*) upkeep and manufacture. The cost of bringing into bearing varies from £18 or £20 upward, the average being about £40 per acre. At 5 per cent this corresponds to a fixed charge of £2 per annum, or assuming that 240 pounds per acre are produced, to 2d. per pound of rubber. With regard to upkeep and manufacture, etc., the following figures are based on the actual working expense of a Malay estate which produced about 100 tons of rubber in 1908,‡ at 200 pounds per acre, and estimated, when mature, to produce 400 pounds per acre:

* Wright. *Hevea Braziliensis*, p. 4.

† India-Rubber Journal, January, 1910.

‡ H. K. Rutherford, India-Rubber J., Q. Cent. No, 1909, p. 60.

	Per pound of rubber produced.
General charges (salaries, allowances, quit rent, hospital, contingencies)	2.31d.
Cultivation charges (weeding, roads, drains, supplying, pests, and diseases, etc.)	1.85d.
Upkeep of buildings	0.23d.
Rubber manufacture:	
Tapping and scrapping	3.93d.
Curing	0.43d.
Packing	0.33d.
Marking, utensils, transport, etc.	0.47d.
Duty	1.19d.
Manufacture—Total	6.35d.
Total working charges	10.74d.

	Per pound of rubber.*
Total charges:	
Fixed	2.00d.
Working	10.74d. (details above).†
Total	12.74d.

To place the rubber on the European market a further 3.30d. (freight, brokerage, etc.) must be added, making a total of 16.04d. or 1s. 4d. per pound. The produce from particularly well placed estates may be put on the European market at 10d. to 1s. per pound; on the other hand there is little doubt that a certain proportion of the planted areas will not show any considerable profit at less than 1s. 6d. to 2s. per pound—or more.

Methods of Manufacture.—The following essential *desiderata* should be aimed at: (1) Collection of maximum amount of latex with minimum of injury to the tree. (2) Absolute cleanliness of collecting and transport vessels. Metal containers should be avoided, glass, earthenware or enameled collecting cups, pails, etc., being preferable. Bare metal certainly affects the color and possibly other qualities of the finished rubber. (3) The latex to be strained or filtered as soon after collection as possible, so that all mechanical impurities may be removed without delay. (4) To restrict, as far as possible, the formation of "bark scrap."

Coagulation and Curing.—The method employed in coagulating the bulk of the plantation rubber consists, substantially, in the addition of a small quantity of acetic acid to the latex after the latter has been strained and preferably reduced to a certain rubber content by mixing of various batches, or by dilution. In most cases, just sufficient acid is added to render the liquid neutral or faintly acid to litmus. After the coagulum has formed it is removed from the mother liquor and passed through the washing rolls, from which the rubber emerges in the form of crêpe, and if this form of rubber is required it passes direct to the drying sheds. If sheet is required the crêpe is passed through a sheeting machine, which consists of rolls revolving at even speed. Intermediate grades obtained by subjecting wet crêpe to the action of even speed rolls are also turned out. In the manufacture of biscuits, now only produced in relatively small quantity, the latex is directly coagulated in circular pans or basins. "Worm" and "lace" rubbers are also produced by passing the coagulum through appropriately designed rolls or dies. In some cases where it is desired to produce rubber of very light color, the crêpe or sheet is passed, before it goes to the drying rooms, through water heated to about 180 deg. F., a process due to Mr. Kelway Bamber, who discovered that *Hevea* latex contains an enzyme which causes the darkening of the rubber, and which can be destroyed by heating to the temperature mentioned. This does not apply to all other latices. Freshly coagulated *Funtumia* rubber is, for instance, perfectly white and may be boiled for a long time with water, but nevertheless darkening subsequently takes place. In the drying rooms the rubber is placed on perforated shelves, or as in the modern practice, is hung from racks. In all modern drying houses provision is made for passing a current of warm air through the same. Partially dried air is preferable, but it is doubtful whether any drying process for this purpose is economical. Another method of drying is by means of the vacuum dryer, in which rubber may be dried in almost as many hours as it takes weeks in the ordinary fashion. It has been said that vacuum dried rubber is not so satisfactory as air dried, but where inferior results are noticeable they are probably due to imperfect methods of applying the vacuum. Thick crêpe is generally prepared by passing several layers of the thin crêpe through the rollers simultaneously. Block rubber is prepared from crêpe by subjecting it to pressure in a hydraulic press while it is still warm from the vacuum dryer.

* Estimated by the writer of this paper.

† According to Rutherford.

Other coagulants than acetic acid are occasionally used, and there are various modifications of the other processes referred to, but substantially the above gives in outline the essential features of the production of Para plantation rubber.

Other Varieties.—With regard to the preparation of varieties other than *Hevea* on the plantation system, such differences as occur in the methods employed are the result of the fact that the inherent properties of different latices vary considerably, and it is therefore necessary to modify the method of coagulation. It may be suggested that this is perfectly obvious, but as a matter of fact much trouble has been caused by efforts to apply to different latices methods which have been favorable in the case of *Hevea*.

Guayule Rubber.—The production of rubber from the Guayule shrub (*Parthenium argentatum*) is of particular interest, because the problems involved are more intricate than those dealing with the production of rubber from ordinary latex bearing plants, and also because guayule is produced on a very large scale, the amount manufactured during the past year being estimated at roughly 4,000 tons. The Guayule shrub, which prefers an altitude of 4,000 to 5,000 feet, is distributed unevenly in a belt of territory from one to a hundred miles in breadth extending roughly from Fort Stockton in Texas to the Tropic of Cancer in Mexico.

In this shrub rubber occurs in solid particles dispersed through the mass of the woody fiber. According to M. P. Fox the wood contains from 6 to 18 per cent of rubber, a similar quantity of resin, and about 10 per cent of extractive. Two processes are employed to separate the rubber from the wood, one consisting in extracting the rubber by means of solvents, and the other, which consists in disintegrating the woody mass in such a manner as to separate the rubber; a combination of the two processes is also employed. Two main grades of Guayule are prepared, one containing about 30 per cent of resin, and the other, from which part of the latter has been extracted, containing about 3 per cent of this impurity. Since the extraction of rubber involves the destruction of the shrub it is estimated that within four years from now practically the whole of the standing shrubs will have been destroyed. For the period 1906 to 1909 some 17,000 tons of rubber were prepared from Guayule, which corresponds on a 7 per cent basis (for wood containing 25 per cent of water) to roughly 328,000 tons of shrubs.

Future of the Crude Rubber Industry.—It is perfectly clear that within a measurable period the crude rubber industry will have undergone a complete change. I believe that in a very few years' time manufacturers will refuse to have anything to do with any raw material that is not perfectly clean and practically dry. Therefore the bulk of the wild rubber in the market will have to be prepared in a different manner, or it will be unsalable. It has already been shown in various parts of the world that the plantation system may, under favorable circumstances, be applied to wild trees, and it seems likely that in time the system of rationally working wild as well as planted trees will be extended over favorable areas. This involves expense in the way of cutting roads and paths, and making arrangements necessary for the transport of latex or rubber bearing wood to central stations. It is obvious that only such areas can be worked as those on which the trees occur in fair number. Probably the most difficult question involved is that of labor. The drawbacks to the rational working of wild rubber are considerable, but on the other hand there are advantages. While it is frequently assumed that the first class of rubber to disappear under the stress of competition will be the inferior African grades, I am by no means sure that this will be the case, because on the whole the question of labor is not so acute in most of the African rubber zones as in South America, and there are already signs that those interested in the West Coast, the Congo, etc., will take the necessary steps to improve the quality of the rubbers from these regions.

With regard to the Para grades the labor problem appears to be a very serious one, and in view of this, and of the extremely unhealthy climate, it is difficult to see how the Amazon valley is indefinitely to maintain its superiority as a producer. Certainly the opening up of the vast forest of Brazil involves the overcoming of apparently insuperable difficulties. The third factor—taking planted and ordinary wild rubber as the two others—in the crude rubber problem, is the preparation of pure high class rubbers from inferior, naturally resinous grades by chemical or other processes. That enormous quantities of resinous rubbers are available is well known. That it is possible economically to purify resinous rubbers appears to be proved beyond doubt by the Guayule industry. I think there is a great future for the subsidiary industries which are likely to arise in this direction.

(To be continued.)

THE STEAM TURBINE.*

ITS THEORY SIMPLY EXPLAINED.

BY WILLIAM E. SNOW.

MODERN steam turbines are divided into two general classes, known as the *impulse*, and the *reaction*, these terms relating to their methods of steam utilization.

In the ordinary accepted meaning of the terms an impulse is a force acting in a forward direction,

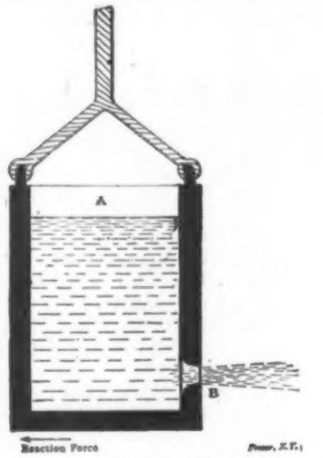

FIG. 1.—SIMPLE REACTION.

and a reaction is a force acting in a backward direction—a resultant of the impulse, and equal to it in magnitude. These terms, however, as applied to steam turbines, are somewhat misleading, as in all impulse turbines the steam acts by impulse on entering and by reaction on leaving the buckets; while

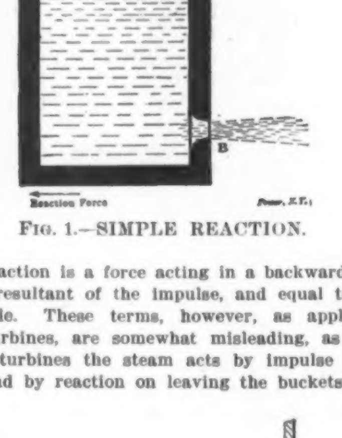

FIG. 2.—SIMPLE IMPULSE.

most so-called "reaction" turbines in reality operate by both reaction and impulse. In order to clearly understand the principal points of difference between the types, let us refer to the graphical illustrations given in Figs. 1, 2, 3 and 4.

Fig. 1 is an example of simple reaction. The vessel *A* is suspended from a cord and filled with water. The water escapes from the orifice or nozzle *B*, and as there is consequently no resistance at this point to the pressure of the fluid in the vessel, the unbalanced force exerted on the walls directly opposite *B* causes the vessel to move reactively in the direction of the arrow.

FIG. 3.—PRINCIPLE OF MODERN IMPULSE TURBINE.

Hero's turbine, invented 120 B. C., shown in Fig. 5, is an excellent example of a purely reaction type. As will be seen, this consisted of the hollow metal globe *A*, mounted rotatively on the uprights *BB* by suitable pivots or bearings. This globe was provided with two bent tubes or nozzles *CC* pointing in tangentially opposite directions. Steam from the boiler *D* was conducted to the globe by one of the supports *B* which was made hollow for this purpose. The steam, issuing from the bent tubes or nozzles *CC*, caused the globe to rotate reactively in a direction opposite to that of the jets. The principle of operation of this turbine was identical with that of the ordinary lawn-sprinkler of the present day, whose rotating arms are moved by the reaction of the water escaping from them.

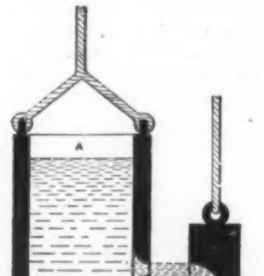

FIG. 4.—PRINCIPLE OF MODERN REACTION TURBINE.

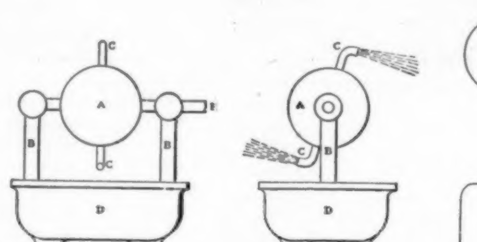

FIG. 5.—HERO'S REACTION TURBINE.

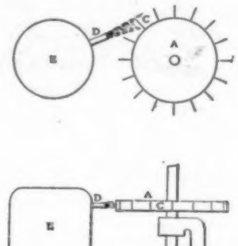

FIG. 6.—BRANCA'S IMPULSE TURBINE.

Fig. 2 is an example of simple impulse. As in the previous case, the vessel *A* is filled with water, but instead of being suspended it is fixed immovably in place. The jet of water escaping from the orifice or nozzle *B* is made to impinge upon the flat plate *C*, suspended from a cord at a suitable height. The pressure of the jet causes the plate *C* to move by impulse in the direction of the arrow. There will also be a reaction force exerted, equal in magnitude and opposite in direction to the impulse. The vessel being in this case fixed immovably, this reaction force does no work.

Branca's turbine, invented 1629 A. D., shown in Fig. 6, is an excellent example of a purely impulse type. As will be seen, this consisted of the wheel *A*, mounted rotatively on the support *B* by means of suitable bearings. This wheel was provided with paddles or buckets *C* similar to those used in water-wheels. A tube or nozzle *D* was placed close to the wheel, so that the issuing steam would impinge on the buckets *C*. Steam was supplied from the boiler *E*, and issuing from the nozzle *D* by its impulse caused the wheel to rotate in the direction of the impinging jet. It is interesting to note that, crude as the Hero and Branca turbines were, they clearly establish the two distinctive classes from which all modern turbines are derived.

In Fig. 3 is an example of the impulse and reaction forces exerted by the working fluid on the buckets of a modern turbine of the so-called "impulse" type. As in the previous case, the vessel *A* is filled with water and fixed immovably in place. In this case, however, the suspended plate *C*, instead of being flat is given a semi-circular form, approximately the shape of the buckets in an impulse turbine. The jet of water escaping from the orifice or nozzle *B* impinges upon this curved surface and is turned back upon itself through an angle of 180 degrees, issuing from the bucket in a direction opposite to that by which it entered. It is, therefore, evident that the jet acts by impulse on entering, and by reaction on leaving the bucket. Since action and reaction are equal, neglecting friction, the combined impulse and reaction forces tending to move the plate *C*, in the direction of the arrow will be twice as great as the impulse force in the previous case, Fig. 2. This is the principle on which the buckets of all modern commercial turbines operate, whether of the impulse or of the reaction type.

In Fig. 4 is an example of the impulse and reaction forces exerted by the working fluid on the buckets of a modern turbine of the reaction type. As in the previous case, the vessel *A* is filled with water, but instead of being fixed immovably in place it is suspended from a cord, as in Fig. 1. The plate *C*, provided with a semi-circular bucket, is also suspended from a cord, as in Fig. 3. The jet of water escaping from the orifice or nozzle *B* impinges on the curved surface of the bucket, tending by its combined impulse and reaction forces to move it in the direction of the arrow. In this case, however, the reaction force, equal in magnitude but opposite in direction to the impulse force, is free to move the vessel *A* in the direction of the second arrow. This is the principle on which modern commercial turbines of the reaction type operate.

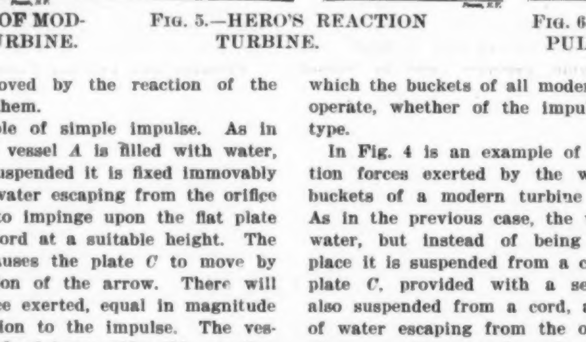

FIG. 7.—BUCKETS AND NOZZLE ARRANGEMENT OF IMPULSE TURBINE.

It is easy to determine whether a turbine belongs in the impulse or the reaction class from the fact that in all impulse turbines the steam pressure is the same on both sides of any one row of buckets; in all reaction turbines there is a fall of the steam pressure in passing any one row of buckets, and the pressure on the two sides of the buckets is not equal. This will be seen more clearly by referring to Figs. 7 and 8.

Fig. 7 shows the bucket and nozzle arrangement of a turbine of the impulse class. In this drawing *B* is the nozzle, *CC* are the rotating buckets moving

* Power and Engineer.

in the direction of the large arrows, and D are the stationary buckets or reversing guide. The steam enters the nozzle B at boiler pressure, and is expanded completely in the nozzle right down to the back pressure of the exhaust, all its available pressure energy being thus converted into velocity energy. The steam, delivered in this form to the buckets, is incapable of any further expansion; consequently the pressure must be the same on both sides of any one row of buckets. This rule holds good, regardless of the number of stages that may be used.

The principle of operation of this type of turbine is shown by the small arrows, indicating the flow of the steam. The steam from the nozzle enters the first set of moving buckets at high velocity, but no appreciable pressure, and is turned through an arc of approximately 150 degrees, whereby a certain portion of its velocity is abstracted and converted into useful work. As the steam issues at greatly reduced velocity from this first set of moving buckets, it is caught by the stationary buckets or guide D and redirected at proper angle into the second set of moving buckets. Here it is again turned through an arc of 150 degrees, and most of its remaining velocity abstracted and turned into useful work.

Fig. 8 shows the arrangement of the stationary and the moving buckets of the turbine of the reaction type. The stationary buckets or guides $B\ B$ correspond to the nozzles in the impulse type of turbine, and $C\ C$ are the moving buckets similar in form to the stationary guides. The steam enters the first set of stationary buckets or guides B at boiler pressure. Owing to the nozzle-like form of these blades, the steam here undergoes a partial drop in pressure, with a corresponding expansion and increase in velocity. As the drop in pressure per stage in this type of turbine rarely exceeds 10 or 12 pounds, the velocity of the steam is not nearly as high as in the case of the greater expansion that occurs in the nozzle of the impulse turbine. The steam issues at moderate velocity, and but slightly reduced pressure, from the guides B and impinges upon the first set of moving buckets C, imparting to them by impulse that portion of its pressure energy that has been converted into velocity by its passage through the guides B. Owing to the shape of the moving buckets, which have the same nozzle-like form as the guides, the steam undergoes a still further pressure drop, with a corresponding expansion and increase in velocity in its passage through. As a result of this increase in velocity, the issuing steam imparts to the buckets by reaction a portion of the pressure energy that has been converted into velocity by its passage through. This same process is repeated in the second set of stationary guides and moving buckets, and so on throughout as many stages as are required to abstract all the available energy from the steam.

It will be noted that the pressure in each successive clearance space between the stationary and moving buckets is lower than in the preceding one. Thus, the pressure at E is lower than at D, the pressure at F is lower than at E, the pressure at G is lower than at F, etc.

From the preceding the following rule is derived for the proper classification of all turbines:

Impulse Turbines—Equal pressure on the two sides of any one row of buckets.

Reaction Turbines—Fall of pressure in passing any one row of buckets.

While the principle of operation of all commercial turbines of the reaction class is practically the same, impulse turbines can be subdivided into several different types, according to their particular method of steam utilization, as follows:

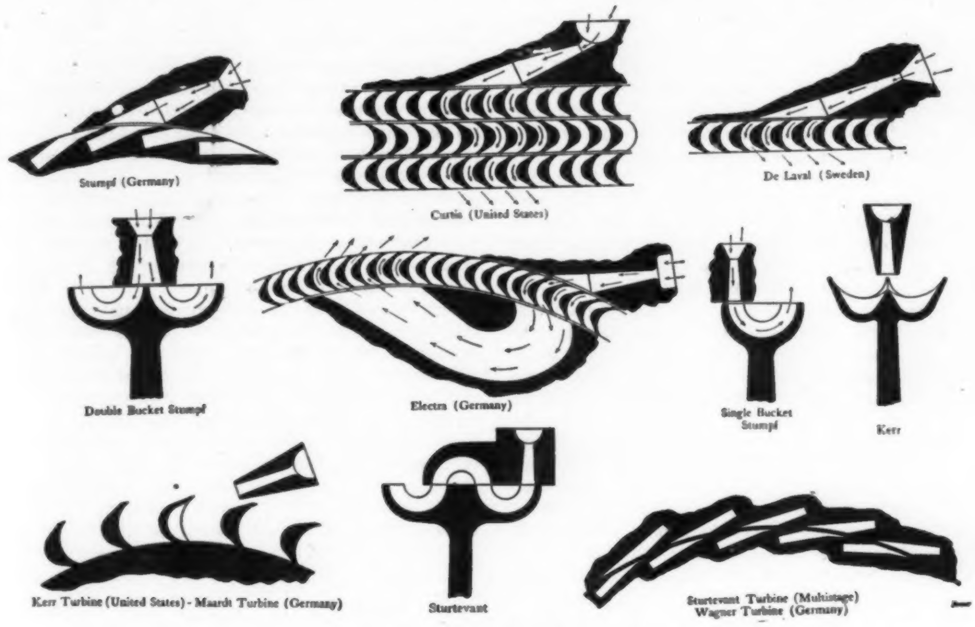

FIG. 9.—VARIOUS TURBINE TYPES.

IMPULSE TYPES.

Single-Stage Type—Turbines with but one set of nozzles and one row of moving buckets.

Velocity Compounded—Turbines with one set of nozzles only, but with two or more rows of moving buckets, with intermediate guides.

Pressure Compounded—Turbines with two or more stages, each stage comprising one set of nozzles and one row of moving buckets.

Pressure and Velocity Compounded—Turbines with two or more pressure stages, each pressure stage comprising one set of nozzles and two or more rows of moving buckets, with intermediate guides.

FARM POULTRY PAYS WELL UNDER RIGHT MANAGEMENT.

"IF farm poultry keeping does not pay, there is usually something vitally wrong with the management of the farm," states Prof. J. G. Halpin, in charge of the poultry department of the College of Agriculture of the University of Wisconsin, in an article in the current number of the Student Farmer, the monthly journal published by students in the college.

"One reason why poultry can be made to pay on the farm," writes Prof. Halpin, "is that the fowls consume much feed that would otherwise be wasted. On the average farm where the poultry is numbered by dozens rather than by thousands, the by-products form a very important part of the poultry feed. Waste materials may be utilized, such as waste from the kitchen table and garden, grains, screenings, etc.

SKIM MILK GOOD CHICK FOOD.

"Skim milk makes an excellent poultry feed, and may be used to moisten a mixture of ground grains, or the milk may be given to hens to drink. When skim milk is abundant it may be heated until the curd forms and this curd fed to the flock. On many farms the supply of meat and milk will be ample to meet the needs of the flock, while on others the supply will be limited and beef scraps or fresh ground green bone should be purchased. Green bone or other meat may form about eight per cent of the total ration in winter. In the summer a well managed farm flock secures many insects which supply the necessary meat for egg production.

"No class of farm stock can utilize screenings so well as poultry. Where the hens are kept in colony houses, they may be moved to different grain fields as soon as the crop has been harvested, and find plenty of feed for several weeks.

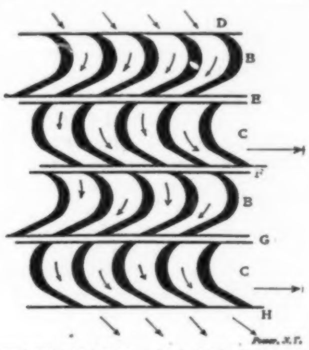

FIG. 8.—STATIONARY AND MOVING BUCKETS IN REACTION TURBINE.

"Clover or alfalfa chaff may be gathered in the barn and given to poultry every few days. We are gradually learning," continues Prof. Halpin, "that bulky feeds, such as the clovers, make good feeds for a part of the egg ration, and form a decided advantage in small cost.

KEEP HENS IN COLONY HOUSES.

"Farm poultry is too often allowed to run in one large flock. The chicks cannot be fed properly, and are almost sure to become infested with lice from the older fowls. Often ducks, geese, chickens and turkeys are all turned together to fight for supremacy. The more the fowls are distributed over the farm in summer the more productive they will be.

"A small patch of sunflowers makes ideal shade, and furnishes excellent feed for fall use. Economy demands that poultry be kept in comfortable houses, not warm, stuffy, damp, ill-smelling places, but in dry, well-ventilated houses, free from drafts. All windows should be removed in the spring and left open until cold weather. Economy also demands that only good stock be kept, and that the poor producers be disposed of. Hens must also be kept free from lice and mites."

IT is stated that Mr. Marconi intends to make a series of tests shortly with a view to ascertaining the practicability of sending wireless messages across Canada.

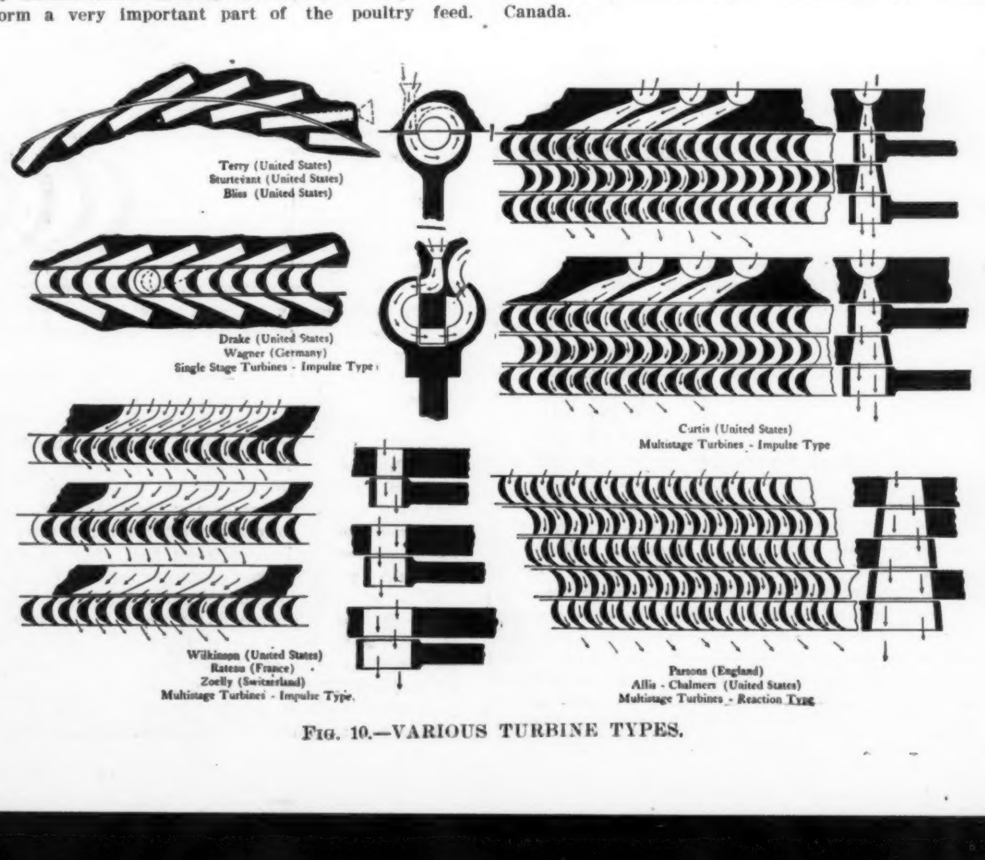

FIG. 10.—VARIOUS TURBINE TYPES.

THE FUTURE OF THE HUMAN RACE.*

A GEOLOGIC FORECAST.

BY PROF. T. C. CHAMBERLIN.

The conditions essential to the maintenance of the habitability of the earth are many, but the more critical factors either lie in the atmosphere itself or are intimately associated with it. The point of keenest interest is the narrowness of range to which these mobile factors are confined. The several constituents of the atmosphere might each or all easily be too scant or too abundant. In a peculiar sense is this true of the carbon dioxide which, though one of the least, is pre-eminently the decisive constituent of the atmosphere. A small proportion of carbon dioxide is essential to plant life and so to animal life, while a large proportion would be fatal to air-breathing animals. If the three or four hundredths of one per cent now present were lost, all life would go with it; if it were increased to a few per cent, the higher life would be suppressed or radically changed. And yet, on the one hand, the theoretical sources of supply are abundant, while, on the other, the agencies of depletion are efficient and active. There is little escape from the conclusion that ever since the birth of air-breathing life, some 30,000,000 or 40,000,000 years ago, let us say, the interplay of these agencies of supply and depletion has been so balanced that neither fatal excess nor fatal deficiency has been permitted to cut short the history of the higher life.

The dangers of excess or deficiency of the other constituents of the air are indeed less narrow when named in percentages, but they are scarcely less real in theoretic possibility.

The well-being of life is hemmed in between a suitable proportion of moisture in the air dependent on a competent area of water-surface to supply it, on the one hand, and a diluvial excess of water, on the other. Universal deluges and universal deserts would alike be disastrous. A few thousand feet more of water-depth or a few thousand feet less would alike seriously restrict the class of life to which we belong.

In even a more serious way the habitability of the earth is conditioned on a narrow range of mean temperature—a range, roundly speaking, of 100 deg. C. This is scarcely 5 per cent of the range of natural temperatures on the earth and a still smaller per cent of the range of temperatures in the heavens. A few miles above us and a few miles below us, fatal temperatures prevail. It is profoundly significant that the thermal states of the narrow zone of life on the face of the earth should have been kept within so close variations as to permit the millions of species forming the great genealogical lines leading up from the primitive types to have perpetuated their lineages in unbroken continuity for such ages, while the prevalent temperatures a few miles above them or a few miles below them, as well as in space generally, would have been fatal. While the necessary heat is dependent on the sun, this control of temperature seems to have been intimately related to the atmosphere and is a further index of its specially critical functions.

To appreciate the full significance of the control of life conditions within these narrow limits when the possibilities were so free and so wide, there is need for some tangible index of the time, but there are at present no means for the close measure of the geologic ages, merely rough estimates of the order of magnitude. Life was far advanced when a readable record first began to be made; but yet since that record began, at least 100,000 feet of sediments—not to choose the largest estimates—have been laid down by the slow methods of wash from the land and lodgment in the basins. The estimate of the years thus represented has been put variously from 50,000,000 to 100,000,000, with indeed higher figures as well as lower. Merely to roughly scale the order of magnitude, and without pretense of accuracy, let us take the midway figure of 75,000,000 years as representative. Let this be divided into fifteen periods of 5,000,000 years each and these will roughly represent the technical "periods" of geologists. By this rough scale we may space out such of the great events as we need now note.

Slight and changeable excesses of evaporation over precipitation and the reverse prevail widely, but only intense and persistent aridity gives rise to thick deposits of salt, gypsum and other evaporation products over large areas—with perhaps some exceptions—for in nearly all large natural basins the area that collects rainfall is notably larger than the closed basin within it that alone can retain water for continuous evaporation. It is therefore fairly safe to infer clear skies and pronounced aridity when beds of salt and gypsum occur over large areas, especially if accompanied by appropriate physical characters and by such types of life only as tolerate high salinity, or show pauperization, or by a total absence of life.

Now extensive deposits of salt and gypsum are found in the Salt Range of India, in strata of the Cambrian period, the earliest of the fifteen that make up our rough scale of 75,000,000 years. Because these lie so near the beginning of the geologic record they afford a singularly instructive insight into the conditions of the atmosphere well back toward its primitive state. They challenge at once the view that in those early ages the earth was swaddled by a dense vaporous atmosphere from pole to pole; for under such a vaporous mantle a great desert tract in India would be scarcely credible.

If we come forward in time two periods, to the deposits of the Silurian stage, we find that underlying the basin of the St. Lawrence in New York and westward there stretch great sheets of salt and gypsum, many thousand square miles in extent. These beds are accompanied by complete barrenness of life in some parts, by pauperization of life in other parts, by selections of life according to tolerance of salinity in still other parts, and by harmonious physical characters, all of which combine to add strength to the interpretation. All these imply a degree of aridity approaching desert conditions in what is now the well-watered region of our Great Lakes. These signal facts join those of the Salt Range of India of earlier date in challenging the former conception of a universal envelope of vapor and cloud in all those early times.

In the next period there are formations that have been interpreted as implying desert conditions, but perhaps on less firm grounds, and we pass on to certain stages in the sub-Carboniferous period next following, wherein beds of salt and gypsum are found in Montana, Michigan, Nova Scotia and Australia, which imply like climatic conditions. If we pass on to the Permian and Triassic periods, near the middle of the geologic series, beds of salt and gypsum are phenomenally prevalent on both the Eastern and Western continents, reaching through surprising ranges of latitude. The relative paucity, as well as the peculiar characteristics of the life of those times, seems equally to imply vicissitudes of climate in which scant atmospheric moisture was a dominant feature. There seems no tenable way to interpret these remarkable facts of the middle periods except by assuming an even greater prevalence of aridity than obtains at the present time. So, at times in the later periods, but at times only, the stratigraphic record implies atmospheres as arid as that of to-day, not everywhere, indeed, but in notable areas and in certain horizons.

These and other significant facts of consonant import form one group of phenomena.

If, on the other hand, the record be searched for facts of opposite import, they will come easily to hand. Starting near the beginning of the record, it is even more easy to find stages abounding in evidences of prevailing humidity, of great uniformity of climate and of most congenial life-conditions reaching through wide ranges of latitude. If we rested on this selection alone, the old view would be abundantly sustained; but the strata bearing evidences of aridity lie between these. Combining the two sets of facts, the conception seems to force itself upon us that from the very earliest stages of the distinct life-record onward, there have been times and places of pronounced aridity much as now, or even more intense, while at other times, intervening between these, more humid and uniform conditions prevailed.

This conception grows in strength as we turn from atmospheric states to prevailing temperatures. The body of scientific men have rarely been more reluctant to accept any interpretation of geologic phenomena than that of recent general glaciation on the low lands of Europe and America in mid-latitudes when that view was first advanced by Louis Agassiz. With the conception of former pervasive warmth then prevalent, it seemed beyond belief that great sheets of ice could have crept over large portions of the habitable parts of Europe and North America some thousands or tens of thousands of years ago. Belief in this was made easier, however, by the view also then prevalent that the earth had been greatly cooled in the progress of the ages, that the atmosphere had been much depleted by the formation of coal, of carbonates and of oxides, that the ocean had been reduced by hydration and entrance into the earth, and that thus a stage had been reached that made possible an epoch of depressed temperature and of glaciation. The ice age, thus theoretically associated, came to be widely regarded as but the first stage in a series of secular winters destined to lead on to the total refrigeration of the earth. This view was abetted by the theory of a cooling sun. The depleting and the cooling processes were regarded as inevitably progressive, and the final doom of the earth as thus foreshadowed in the near future, geologically speaking.

But opinion was scarcely more than adjusted to this view when the geologists of Australia, of India and of South Africa, severally and independently, and later those of South America presented evidences of former glaciation over extensive areas in those low latitudes. The typical marks of glaciation were indeed traced even up to and a little across the tropical circles from the south, in Australia, and from the north, in India. Moreover, all these were reported from strata of Permian or late Carboniferous times, *i. e.*, from the sixth or seventh of the technical "periods." For a score of years the body of geologists not in immediate contact with the evidence itself, doubted the interpretation, but the growing evidence grew at length to be utterly irrefutable. There seems no rational escape from the conclusion that mantles of ice covered large areas in the peninsula of India, in Australia, in the southern part of Africa, and in South America, close upon the borders of the tropics, at a time roundly half way back to the beginning of the readable record of life.

On the basis of similar evidence, Strahan and Reusch have announced glacial beds in Norway at a horizon much lower but not closely determinate. Willis and Blackwelder have described glacial deposits of early Cambrian age in the valley of the Yangtze in China in latitudes as low as 31 degrees. Howchin and David have described glacial formations of similar age in Australia. In the last two cases the glacial beds lie below the strata that bear the Cambrian trilobites; in other words, they lie at the very bottom of the fossil-bearing sediments, fifteen periods back, or 75,000,000 years ago on our rough scale. Professor Coleman has offered what he deems good evidence of glaciation much farther back at the base of the Huronian in Canada, but some skepticism as to its verity has yet to be overcome.

Even more pointedly than the epochs of aridity, do these early epochs of glaciation seem incompatible with the view of a hot earth universally wrapt in a vaporous mantle in early times. They favor the alternative view of merely temporary localized intensifications of climate which life was able repeatedly to survive. This seems to warrant the belief that life may survive similar intensifications again and again in the future.

At present polar and alpine glaciation are contemporaneous with aridity. There are reasons for thinking that the past glaciations and aridities were in some similar way correlated and that they co-operated to give vicissitude to the climates of certain geologic epochs. The known epochs of glaciation, however, are fewer than those of aridity.

On the other hand, at several stages, as already noted, abundant life, bearing all the evidences of a warm-temperate or sub-tropical character, flourished in high latitudes. In Greenland, Spitzbergen and other Arctic islands are found the relics of life not known to be able to live except under conditions of genial warmth. These imply former sub-tropical conditions where now only frigidity reigns.

In the light of these contrasted climatic states of aridity and glaciation, on the one hand, and of uniformity and geniality in high latitudes on the other, intervening between one another, we seem now forced to the conception of profound climatic alternations extending over the whole stretch of known geologic time. Concurrent with these alternations there may perhaps have been variations in the constitution, as there certainly were in the condition, of the atmospheric.

If we turn to the relations of the waters and the land, an analogous oscillating history presents itself. This was possibly connected casually with climatic oscillations. At no time in the history recorded by clear geologic testimony is there proof of the absence of land, and certainly at no time is there a hint of the absence of an ocean, whatever theoretic views may be held of the earliest unknown stages.

The progress of inquiry seems to force the con-

* Abstract from address of the president of the American Association for the Advancement of Science, Boston, December 27th, 1909.

viction that the land area in the earliest stages of good record was quite comparable to that of the present time, both in its extent and in its limitations. Following down the history, the land area seems at certain times to have been larger than now, while at other times it was smaller. There appears to have been an unceasing contest between the agencies that made for the extension of the land and the agencies that made for the extension of the sea. While each gained temporarily on the other, complete victory never rested with either. From near the beginning of the readable record there appears to have been an unbroken continuity of land life, and from a like early stage, an unbroken continuity of marine life. Probably the history of both goes back unbroken into the undeciphered eras which precede the readable record, and no one to-day can safely affirm the precedence of either over the other, either in time or in genesis, whatever his theoretic leanings may be.

Among the agencies that may be assigned for the extension of the land are those that deform the body of the earth, deepening its basins and drawing off the waters, while other portions are protruded and give renewed relief and extent to the land. Among the agencies that make for the extension of the sea are the girdling of the waves about the borders of the land and the decay and wash of the land surface which is thus brought low at length and covered by the advancing waters. If the deformation of the earth-body were held in abeyance for an indefinite time, the lowering of the land, the filling of the basins, and the spreading of the sea would submerge the entire land surface and bring an end to all land life. Great progress in such sea-transgressions appears to have been made again and again, until perhaps half the land was submerged, but before land life was entirely cut off or even very seriously threatened, a regenerative movement in the body of the earth intervened, the land was again extended and the sea again restricted. Here then, also, there has been a reciprocal movement which, while it has brought alternate expansions of land life and of sea life, has, notwithstanding, permitted the preservation of both, and thus maintained the continuity of the two great divisions of life.

It appears, thus, that in each of the great groups of terrestrial conditions upon which life is dependent, there has been, through the known ages, vast as they are, an oscillatory movement which has brought profound changes again and again, but has never permitted any of the disasters threatened in these movements to go far enough to compass the universal extinction of life. These reciprocal movements appear to be dependent upon a balancing of the action of agencies that is scarcely less than a law of equilibrium. It is not too much to regard this as a regulative system. A clear insight into the agencies of this regulative system is rather a task of the future than an attainment of the present, and I can only offer tentative hints of what may prove to be its main factors and beg of you to accept them with due reserve.

The preservation of the land against the incessant encroachments of the waters seems probably due to a periodic deformation of the earth-body dependent on internal dynamics not yet well understood, at least not yet demonstrated to general satisfaction. The body of the earth feeds its atmosphere through volcanic and other means. How far this is merely a return of what has been absorbed earlier it is not prudent here to say, as opinion is not harmonious on this, and the evidence is as yet uncertain. Much depends on the constitution of the earth's interior and that in turn hinges on its mode of origin. Perhaps it will be agreed generally that feeding from the interior is one of the sources of supply which offsets the depletion of the atmosphere caused by its union with earth substance, in short that the earth-body gives out as well as takes in atmospheric material. Important or unimportant as this may be, it is not apparent that there is in it any automatic balancing suited to control the delicate adjustments requisite for continuity of life. The ocean acts as an important regulator by alternately absorbing and giving out the atmospheric gases as required by the state of equilibrium between the water and the air. This action is automatic but has its limitations and peculiarities, and does not seem wholly adequate. If we are able to name such an adequate automatic action at all at present, it probably lies in the molecular activities of the terrestrial and solar atmospheres and in the relations of these to the gravitative powers of the earth and the sun.

If analysis of the molecular action of the outer atmosphere be pushed to its logical conclusions, it leads to the conception of supplementary atmospheres, in part orbital, filling, in their attenuated way, the whole sphere of the earth's gravitative control. A similar study of the sun's atmosphere suggests a similar supplementary extension and this extended portion surrounds and embraces the earth's atmosphere. Under the laws of molecular activity these two atmospheres must be interchanging molecules at rates dependent on the conditions of equilibrium between them.

It is reasonable that an excess in the earth's atmosphere should cause it to feed out into the sun's sphere of control more than it receives, and that a deficiency in the earth's atmosphere should cause more feeding in from the sun's supplementary atmospheres than the earth gives out. If this conception be true and be efficient, the maintenance of the delicate atmospheric conditions required for the continuity of life is automatically secured. The failure of our atmospheric supply is thus made to hang, not simply on the losses and gains at the earth's surface, but on the solar interchange and hence on the solar endurance.

The sun is giving forth daily prodigious measures of energy. The endurance of the sun is not, however, merely a question of unrequited loss, for it gains energy and substance daily as well as loses, but so far as present knowledge goes, its gain is greatly inferior to its loss. So long as the heat of the sun was supposed to be dependent on ordinary chemical changes, or on the fall of meteorites, or on self-contraction, an activity adequate for terrestrial life could only be estimated at a few million years. But recent discoveries in radio-activity have revealed sources of energy of an extremely high order. In the light of these the forecast of the sun's power to energize the activities of the atmosphere dependent on it and to warm the earth is raised to an indeterminate order of magnitude.

If we may thus find grounds for a complacent forecast in reciprocal actions on the earth and in reciprocities between the earth and the sun, are we free from impending dangers in the heavens without?

Present knowledge points to one tangible possibility of disaster; collision with some celestial body, or close approach to some sun or other great mass, large enough to bring disaster by its disturbing or disruptive effects. Within the solar system, the harmonies of movement already established are such as to give assurance against mutual disaster for incalculable ages. Comets pursue courses that might, theoretically at least, bring about collision, but do not appear usually to possess masses sufficient to work complete disaster to the life of the earth even should collision occur, whatever local disaster might follow at the point of impact. The motion of the stars, however, lie in diverse directions, and collisions and close approaches between them are theoretically possible, if not probable, or even inevitable. There are also in the heavens nebulæ and other forms of scattered matter, and doubtless also dark bodies, which may likewise offer possibilities of collision. The appearance of new stars flashing out suddenly and then gradually dying away suggests the actual occurrence of such events. It has been even conceived that the close approach of suns is one of the regenerative processes by which old planetary systems are dispersed and new systems are brought into being. One phase of the planetesimal hypothesis is built on this conception and postulates the close approach of some massive body to our ancestral sun as the source of dispersion of a possible older planetary system and the generation of the nebulous orbital condition out of which our present system grew. However this may be, it must be conceded that in collision and close approach lie possibilities, if not probabilities, of ultimate disaster to the solar system and to our earth. But here, as before, the vital question lies in the time element. How imminent is this liability? The distances between stars are so enormous that, though they move diversely, the contingencies of collision or disastrous approach are remote. Nothing but rough computations based on assumptions can be made, but these make disaster to a given sun or system fall on the average only once in billions of years. There is no star whose nearness to us, or whose direction of motion is such as to threaten the earth at any specific period in the future. There is only the general theoretical possibility or probability. While, therefore, there is to be, with little doubt, an end to the earth as a planet, and while perhaps previous to that end conditions inhospitable to life may be reached, the forecast of these contingencies places the event in the indeterminate future. The geologic analogies give fair ground for anticipating conditions congenial to life for millions or tens of millions of years to come, not to urge the even larger possibilities.

But congeniality of conditions does not ensure actual realization. There arise at once questions of biological adaptation, of vital tenacity and of purposeful action. Appeal to the record of the animal races reveals in some cases a marvelous endurance, in others the briefest of records, while the majority fall between the extremes. Many families persisted for millions of years. A long career for man may not therefore be denied on historical grounds, neither can it be assured; it is an individual race problem; it is a special case of the problem of the races in the largest sense of the phrase.

But into the problem of human endurance two new factors have entered, the power of definite moral purpose and the resources of research. No previous race has shown clear evidence that it was guided by moral purpose in seeking distant ends. In man such moral purpose has risen to distinctness. As it grows, beyond question it will count in the perpetuity of the race. No doubt it will come to weigh more and more as the resources of destructive pleasure, on the one hand, and of altruistic rectitude on the other are increased by human ingenuity. It will become more critical as the growing multiplicity of the race brings upon it, in increasing stress, the distinctive humanistic phases of the struggle for existence now dimly foreshadowed. It will, beyond question, be more fully realized as the survival of the fittest shall render its verdict on what is good and what is evil in this realm of the moral world.

But to be most efficient, moral purpose needs to be conjoined with the highest intelligence, and herein lies the function of research. None of the earlier races made systematic inquiry into the conditions of life and sought thereby to extend their careers. What can research do for the extension of the career of man? We are witnesses of what it is beginning to do in rendering the forces of nature subservient to man's control and in giving him command over the maladies of which he has long been the victim. Can it master the secrets of vital endurance, the mysteries of heredity and all the fundamental physiological processes that condition the longevity of the race? The answer must be left to the future, but I take no risk in affirming that when ethics and research join hands in a broad and earnest endeavor to compass the highest development and the greatest longevity of the race the era of humanity will really have begun.

GIRLS NEED SCIENCE FOR GOOD HOME MAKING.

"THE girl who has learned to correlate her studies in science, art, literature and language to the issues in her own life through applied knowledge in household economics, not only will have a basis on which to build for any work—good health and a clear brain—but will have a foundation for the profession of home making which, in the end, is woman's highest calling," said Prof. A. L. Mariatt, head of the University of Wisconsin home economics course, before the Federation of Women's Clubs convention at Waterloo.

"The girl who has studied the yeast plant, analyzed the flour, studied the cooking range, applied her chemistry to food analysis, her history to the evolution of industry and home standards, her book-keeping to problems of expenditure for a family of limited income, is prepared to do her work as a home maker most efficiently and economically.

"This means that all should receive manual and vocational training in the grades, and that high school courses in applied science must be credited in preparation for the colleges and normal schools, so that each pupil will have a right to practical knowledge, whether or not her desire or aim leads to higher institutions before entering on life's labors."

WIRELESS TELEGRAPH ON THE UNION PACIFIC RAILROAD.

THE Union Pacific Railroad commenced the installation of a system of wireless telegraphy along its road. A powerful station already has been established at Omaha, Neb., capable of communicating with the smaller stations along the line, and towers will be erected now at Sydney, Neb., and Cheyenne, Wyo. The work of installation is under the direction of Dr. Frederick H. Millener, experimental electrician of the Union Pacific railroad, who left Omaha this week to supervise the erection of the stations at the places mentioned. They will be finished and put in operation as soon as possible. The first work of the towers will be to facilitate railroad telegraph business during wind and snow storms, and later on, efficient communication with moving trains. Dr. Millener has been conducting experiments at the Union Pacific shops in Omaha for nearly four years, and the new installation is the result of these investigations.—The Railway and Engineering Review.

Elastic Dammar Varnish for Paper.—Pulverize 40 parts of pale, transparent dammar gum and pour over it 200 parts of acetone. Allow it to digest for 14 days, at 78 degrees to 86 degrees. Pour the solution carefully off of the deposit and mix with 30 parts of thick-fluid collodion and 40 to 60 parts of pale shellac varnish.

ELECTRICAL NOTES.

A 100-kilowatt hydro-electric plant of the Elkhart River, near Syracuse, Ind., utilizes a drop of 10 feet in the stream. The quantity of water required is 10,000 cubic feet per minute, which is deflected by a dam only 30 inches high. The minimum stream flow is twice that utilized. The head-race from the dam to the power-house is three-quarters of a mile long. Two 100 horse-power vertical turbines are geared to a horizontal shaft, from which a belt drives a 100-kilowatt, 2300-volt three-phase, 60 cycle self-exciting alternator at 900 revolutions per minute. The current is transmitted a maximum distance of 11 miles at a voltage of 6600. Much of the current is sold to farmers for lighting their buildings and running small motors. The remainder is sold in Syracuse.

Stahl und Eisen has compiled a list of the electric furnaces now at work smelting iron or steel. The list totals 114 furnaces for steel making, of which 77 are classed as arc furnaces, two generate their heat by a combination of arcs and resistance, and 35 are induction furnaces. There are also two or three pig iron smelting furnaces in Norway and Sweden, but this list is obviously incomplete, as it omits the furnaces of the Shasta Iron Company, in California, U. S. A. Seven of the steel furnaces are at work in England and a number in America, but the great majority are on the Continent, principally in France and Germany. Most of the furnaces are of small capacity, generally between one and five tons, and are engaged upon high-class steels, but a fair proportion are working on ordinary steels, such as structural steel, steel castings, and railway material—tires, rails, etc., The rapid growth in the number of these furnaces indicates that they are a commercial success for certain classes of work.

Rossi's magnetic detector of Hertzian waves is composed of a fine iron wire, stretched in the magnetic field of two bar magnets, which are placed in the same line, parallel to the wire, with their like poles pointing in opposite directions. The wire bears a small mirror at its middle point, and is surrounded by a coil of wire which is traversed by an alternating current, whose frequency is equal to that of the torsional oscillation of the wire around its axis. Hence the mirror is caused to oscillate and its oscillations are increased to a maximum by resonance. The stretched iron wire is inserted in the circuit of the antenna, so that its hysteresis is modified and the amplitude of oscillation is diminished, whenever it is traversed by the currents of high frequency which are produced in the antenna by the arrival of Hertzian waves. The signals thus received can be photographically recorded by means of a ray of light reflected by the mirror. In contrast to other wireless detectors, Rossi's device can be adjusted for various frequencies and it is affected only by trains of waves of a very small range of frequency.

ENGINEERING NOTES.

During 1908, and the nine months ending with September, 1909, 286 miles of new railway were thrown open to traffic in Russia, while 83½ miles of second track were laid down. The total length of the railway system of Russia, in Europe and in Asia, amounted last autumn to 41,648 miles, exclusive of the Eastern China Railway, which is 678 miles in length, and also of the Finnish railway system, which has a length of 2,124 miles.

A machine belting of paper is manufactured in England, which is said to be very strong and durable. The paper is specially prepared and compressed and cut into links, which are punctured at the ends and fastened together by a wire rod and protected on the margin by single heavy leather links. The belting will not stretch and where tried is reported to give perfect satisfaction. It is said not to be affected by climatic changes and conditions.

The annual consumption of coal in Germany and some of the principal German cities is as follows: German Empire, 137,000,000 tons; Berlin, 5,700,000 tons; Leipzig, 1,685,000 tons; Cologne, 1,625,000 tons; Dresden, 1,174,000 tons; Munich, 852,000 tons; Bremen, 371,000 tons. The steams of the North German Lloyd Company consume annually 1,740,000 tons of coal, an amount equal to 1.3 per cent of the annual coal consumption of the German Empire, or to 30.5 per cent of that of Berlin, and greater than that of any other German city. As this company owns 2.1 per cent of the commercial ocean steam tonnage of the world, the annual consumption of coal by ocean steamers may be estimated at about 82,000,000 tons, or about 8.2 per cent of the world's annual production.

Many American railway cars are carried on trucks which have three pairs of wheels. This construction almost entirely prevents the jolting in passing over the ends of rails which is so annoying when the old style of truck, with four wheels, is employed. When the front wheel of a four-wheeled truck has passed the last of the cross-ties which support the rail on which the wheel is rolling, the end of the rail is bent downward by the pressure exerted by the wheel, which is equal to about one-eighth of the weight of the car. Hence the wheel strikes violently against the end of the next rail, which is not correspondingly depressed. The front wheel of the six-wheeled truck reaches the junction of the two rails before the middle wheel has passed the last cross-tie, so that the middle and rear wheels rest on the rigid part of the rail. In these conditions there is no tendency for the flexible porti to bend. The rail remains straight and in line wi the next rail, and no jolt is produced. In order accomplish this result the distance between the t cross-ties nearest the junction must be less than t distance between two consecutive axles of the truck.—La Nature.

TRADE NOTES AND FORMULÆ.

Fireproof Dinas Mass (according to Nehse).—Quartz sand, 100 parts; caustic lime, 7 to 8 parts kaolin, 3 to 4 parts, are very thoroughly mixed an not moistened until the mass is about to be presse into the molds.

Parisian Ebony Stain (according to Lauber).—Di solve extract of logwood in hot water until the sol tion shows 10 deg. Bé.; mix 5 parts of this solutio with 2.5 parts acetate of iron of 11 deg. Bé and 0. parts of acetic acid of 2 deg. Bé and heat the whol for about a quarter of an hour. The stain is to b used cold.

Copal Varnish (according to Heeren).—Dissolve parts of West Indian copal in 60 parts of highest pe cent spirits, 10 parts ether, 40 parts oil of turpentin by gently heating. This succeeds only with the varieti of copal, that, in the above named solvents are n merely softened but actually dissolved—the copal mu therefore be tested first as to its solubility.

Covering Varnish (Resistant).—

	I.	II.	III.
Amber rosin............	80	70	60
Copal gum, melted......	40	..	..
Linseed oil varnish.....	10	10	8
Oil of turpentine.......	100	200	160
Venice turpentine.......	..	10	..
Colophony (rosin)	..	..	20

Imitation of Ebony-Wood.—Chlor-hydrate of aniline 10 parts; alcohol, 10 parts. This solution must be applied to the wood, which must previously have been treated with a solution of 1 part sulphate of copper (blue vitriol) in 100 parts of water, and allowed to become thoroughly dry, before applying the aniline salt solution. The latter can best be applied by means of a soft little sponge and the wood will then be colored to a certain depth, a deep black.

Frosted Glass.—The frost work on glass can be permanently imitated by sifting white enamel powder on a sheet of glass and then exposing it on an iron plate cooled to below the freezing point to water vapors. The latter crystallizes in the well-known ice blossom or crystal form, uniting at the same time with the enamel powder, which on drying, forms the frost work. The enamel powder must afterwards be burned in.

Ebony Mass (according to Gottschalk).—Boil fine sifted hardwood saw-dust with a stain made from 2 parts of logwood extract, 10 parts of water and 0.25 part of alum for 10 hours; allow it to drain and then place it in a bath of 15 parts water and 1 part blue vitriol, allow it to remain there 5 hours, take it out, treat it in a centrifugal machine, dry it, mix with blood albumen, and compress the coarse-grained mass in heated metal moulds, by means of a press.

Coumarin is a crystalline body, found most abundantly in the tonka bean, in woodruff, clover (mellilot) and spring glass. It is obtained from the tonka bean by distillation with water, after 24 hours, the coumarin in the distillate separates in crystals, crystals with a silky gloss that melt at 152.6 deg. F. and have a very agreeable odor of woodruff. It is used in perfumery ("new-mown-hay"), in the manufacture of liqueurs and in the production of essence of woodruff. Another process for obtaining coumarin: Crushed tonka beans are boiled several times in spirits of wine, the fluid distilled and the residue, consisting of fat and coumarin, treated with boiling water. The boiling solution is quickly filtered through moistened paper which retains all the fat. From the hot solution the coumarine crystallizes out, in the form of very delicate needles. These are readily soluble in boiling water, also in alcohol melt at 152 deg. F. (67 deg. C.) and boil at 553 deg. F. (290 deg. C.).

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